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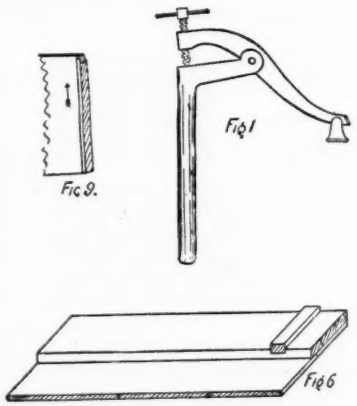
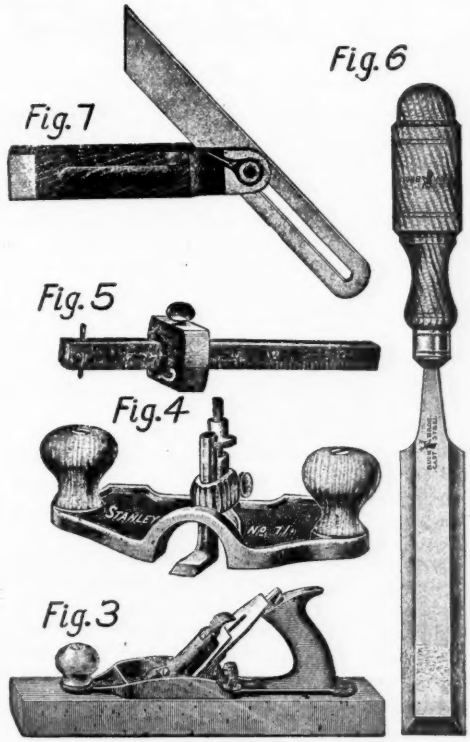
SIMPLE LESSONS IN WOOD INLAYING.

A. C. HORTH.

Inlaying is a craft that allows of no scamping, and should be attempted by no one who expects to get good results with little work. Its difficulties, however, are more apparent than actual, and are overcome without much trouble if the worker is content to start from the beginning. The expense for tools and materials is slight. The following tools will suffice at first: A strong bench, provided with a vise and holes for a holdfast, Fig. 1, a trying plane either of wood, Fig. 2, or iron; assorted firmer chisels, Fig. 3, 1 in., ¾ in., ½ in., ¼ in. and 1-8 in.; a router, Fig 4, tenon saw, gauge, Fig. 5, smoothing plane, shuting board, Fig. 6, bevel. Fig. 7, square rule, and mallet.



A first attempt may be made on a simple teapot stand, such as is illustrated herewith. Plane up the surface of a piece of ¾ in. wood quite smooth and the edges square on the board, being very careful when planing across the end grain to cut off the far corner, to the line, as shown in Fig. 9. When this is ready, set the gauge to 1 in. and gauge a line from each side. Next, set to 1½ in. and run a set of lines inside these lines, and then with the square and a penknife cut in these lines as well as a 1½ in. square in the center. Now take a chisel and pare out the waste wood from between these lines to a depth of 1-8 in., finishing with the router, the iron of which should project exactly 1-8 from the sole. This plane will clean up the bottom of the grooves, and ensure them all being at the same depth.



The wood to be inlaid should now be planed up to size on the shuting board. It should be slightly wider than the space it is to fit in, and of course a little thicker. Having planed up the pieces, fit in the cen-

ter, but do not drive it home. Next fit the border, very carefully making the joint at the corners, called a "mitre." When the fitting is complete, run some thin glue into the grooves and on to the pieces and drive them in with the mallet. The work should be cleaned up with the smoothing plane when the glue is quite set, on no account before, and then the edges chamfered to complete the stand.

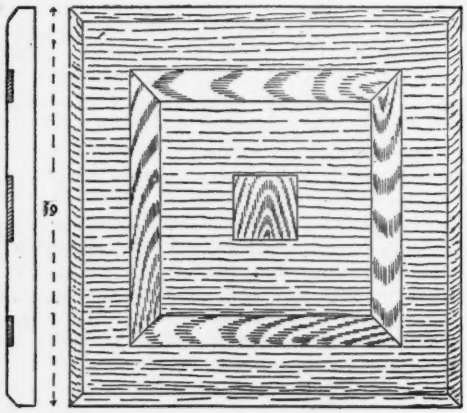


FIG. 8. SIMPLE PATTERN FOR FIRST ATTEMPT.

In cases where it is impossible to get the wood quite smooth, a scraper should be used. A piece of broken glass makes an excellent scraper, and, if carefully used, will clean up the whole surface. Finish it off with glass paper polishing.

pieces are planed up exactly true and an extra one is added. These pieces are then glued together, and when the glue is perfectly set strips are sawn off and placed together, after being planed up on the shuting board and moved along in alternate strips to get the chequered effect. They are then glued up on a piece of stiff paper. In making similar patterns to these, it is of the utmost importance that the planing be true, and each strip exactly the same width.

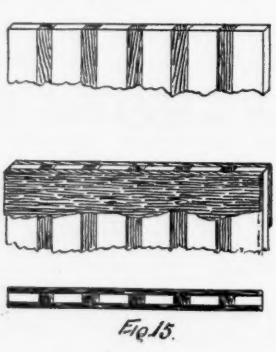


FIG 15.

FIG 16.

FIG 17.

Bandings for inlaying borders are made by sawing narrow strips of the piece just described, as illustrated in Fig. 14. A more elaborate yet very simple piece of banding is shown in Fig. 15. To make it, first of all get out a series of strips and glue them up; next glue on each side, after cleaning off the glue and scraping over both surfaces with the saw edge, a thin piece of board, and put under pressure until dry. The banding

FIG 10.

FIG 11.

FIG 12.

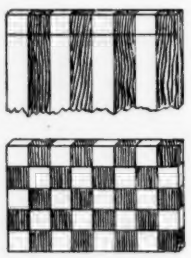


FIG 13.

FIG 14.

To continue the work a stage further, an inlay of some simple ornament, such as the star shown in Fig. 10, may be used instead of the square in the center. It should be made of two contrasting woods, such as sycamore or holly and walnut or rosewood, and cut from a strip of wood in the way shown in Figs. 11 and 12. The latter method, although economical, is not always the most suitable, for the grain should always be studied.

Fig. 13 illustrates how a chequers pattern is produced. The operation is simple. When the size of the square is determined, the requisite number of is made of strips sawn off the end and planed up smooth.

Corner pieces are also easily made; two of simple patterns are shown at Figs. 16 and 17. The former, the more difficult of the two, is composed of a square piece of wood, with a piece of square section in each corner. Fig. 17 is much the easier; four strips for inlaying are sawn off the end the required thickness.

For those workers in inlay who wish for a piece of work to advance their skill and utilize some of the above pieces of work, the design for an inlaid chessboard is given to enable the worker to utilize his prac-

tice. The pattern, which consists of 1¼ inch square, should be made and then inlaid. A banding, made up in a similar manner to that shown at Fig. 25, should be let in as a border, with corners to match built up

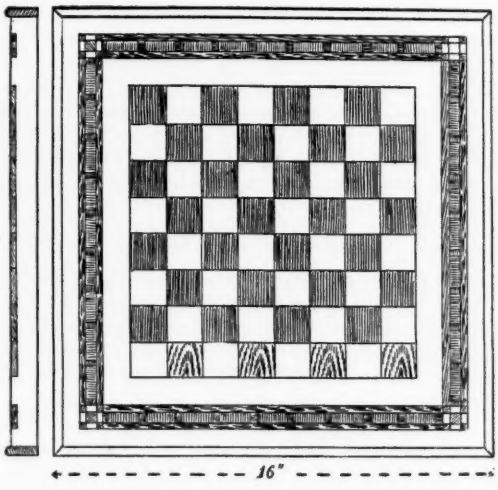


FIG. 18. SIMPLE INLAID CHESS-BOARD.

like Fig. 16. A half-round rim should be screwed on to give a finish to the work. The same idea might easily be carried out in the form of a table, which should afterwards be French polished.—"Arts and Crafts."

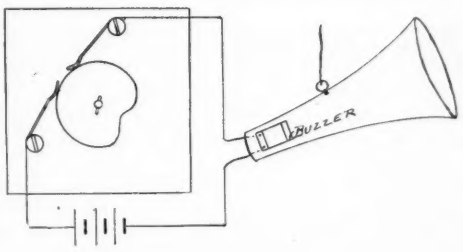
OUTWITTING THE ROBINS.

CARL B. FAUME.

Last year our cherry trees suffered from the depredations of robins, and we lost many baskets of luscious "white hearts" in consequence. This year our trees have blossomed so luxuriantly that I have devised a simple device to scare away the marauders, and, believing that many readers of AMATEUR WORK have a need for the same device, I herewith give a brief description of it.

I first procured a Lungen buzzer at an electrical supply house, also two coils of dry battery and some cheap No. 16 wire. Procuring a piece of sheet tinned iron, I constructed a horn shaped affair, about 12 in. long, 4 in. in diameter at the larger end and 2 in. at the smaller end. Two pieces of insulated wire were fastened to the buzzer binding posts and the buzzer then fastened securely into the horn, at the small end.

It is not desirable to have the buzzer constantly in operation in the cherry tree, as the birds will become familiar with the sound and soon have no fear of it. I therefore arranged the mechanism of an old clock so as to obtain a contact for three-fourths of a revolution of one the cog wheels, by constructing a simple interrupter and two brushes as shown in the diagram. The interruption takes place when the wipe between the brushes and metal disc is broken. In this way the buzzes are irregularly intermittent and, with two or three cells of battery in the circuit, very vigorous. It is advisable to suspend the horn by a wire in the middle



branches, where the wind may cause it to swing as it buzzes. The batteries may be placed in a rain-proof box near the tree, or in the house if you have wire enough to run the line, sufficient allowance being made for loss of battery owing to the resistance of additional wiring. This device is also suitable for suspension over a strawberry bed.

The Westminster Bridge to Tooting tramway will be constructed by the London County Council on the conduit system, at an estimated cost of £251,900. The adoption of the trolley system would have meant a decrease in the capital expenditure corresponding to a reduction of £1,900 in the annual cost of upkeep. The advantage obtained in return for the extra cost has been the absence of any disfigurement of the streets.

The fire risk with incandescent lamps is commonly supposed by the ordinary user to be *nil*, but "Cassier's Magazine" publishes a reminder that while the view is fairly warranted, it is not altogether accurate. For example, in three months of last year at least five fires were caused by the ignition of inflammable materials due to heat generated by electric incandescent lamps. Systematic tests have been made to determine the heating effects of and the extent of the danger of fire from these lamps when in proximity to inflammable materials, and it was found that a 16-candle-power incandescent lamp, immersed in ½ pint of water, caused the water to boil within an hour. A similar lamp, encased in two thicknesses of muslin, caused it to smoke in three minutes, and in six minutes, when fresh air was admitted to the interior, the muslin burst into flame. A newspaper against which the lamp pressed, ignited in three quarters of an hour, and an article of celluloid ignited in three minutes under the same conditions. There is, however, no comparison between security from fires due to the use of the incandescent lamp and that of oil lamps; the published statistics show that accidents and explosions due to the use of oil lamps number many thousands every year.

A CHEAP NINE-INCH REFLECTOR.

M. A. AINSLEY.

I. Tools and Materials Needed.

The telescope I propose to describe was made some two years back, and since it was finished several improvements and alterations have occurred to me—these I will indicate as I proceed. I will devote this letter to a brief summary of the methods I used and the materials required.

The speculum (and this applies to the second 9 in. mirror also) was worked by hand on a glass tool of the same size, the latter being supported on a stout box which was fixed to the top of a cask. The speculum was cemented with pitch to a wooden handle until the fine-grinding was completed, when it was held in a tight wooden triangle, just tight enough to hold it without undue pressure or freedom. The mirror was figured on a graduated polisher (to be described later) and tested by the Wassell method, though my apparatus was considerably simpler than Mr. Wassell's. Having nothing in the way of a workshop (in fact, a good deal was done out of doors), and only a few hand tools, I was largely dependent on the local carpenter and blacksmith, so that anyone with a small workshop and some skill as a carpenter would make a material reduction in the cost.

As to the materials, the glass will be the first thing to get. I was advised to have my 9 in. mirror 1½ in. thick; but I found a good deal of difficulty in procuring glass of this thickness, and had to be content with 1 in. This has proved ample in practice—with care in supporting the mirror, to avoid flexure—but as Dr. Common said in a letter to me: "If your 9 in. were 1½ thick it would not suffer from flexure, however supported." So I should advise 1½ in., or about one-sixth of the diameter of the mirror. I expect 1½ in. would be thick enough for any size up to 10½ in. or even 12 in. They should be roughly ground circular, and the sharp edges removed. Fine grinding of the edges is unnecessary.

THE BENCH OR SUPPORT FOR TOOL.

An old paraffine cask was what I used; but it was not high enough for me, as I stand 6 ft. 2 in., so I raised it another 6 in. or so by means of a stout box, which should be as flat as possible, to keep the tool in place. I found this quite steady, though I think it would be better still to fill both box and cask with stones, earth or something heavy enough. The surface of the tool was high enough to be about 5 in. below the point of my elbow when standing upright. This gave command of the work and avoided stooping, while I could put sufficient pressure on the mirror during grinding to make the emery do its work. I did not find it necessary to fix the tool down (with pitch or otherwise), and if there was any flexure of the tool during the work, it has no perceptible effect on the figure of the completed mirror. The same tool was used to grind both mirrors; the second mirror, however, seemed to be quite rigid enough to impart a good spherical figure to the mirror.

THE GRINDING MATERIAL.

Throughout the grinding operations I used ordinary emery. I understand that "carborandum" is a much more effective grinding material, and I am told it cuts far more rapidly; but it is much more expensive, and as yet I have not tried it; but if I do any more work of this description I shall certainly do so.

For the rough grinding, emery of the grade known as "1½" was used. Sand is a good material for the purpose. In fact, it is recommended by Dr. Common; but I had no supply on hand, and I have found from past experience that the use of it lengthens the rough grinding considerably. It cuts well when quite fresh, but very soon seems to wear down and so has to be very frequently renewed. I tried rough-grinding with coarser emeries, even as coarse as No. 4½, but the edges of both tool and mirror were badly chipped; and it appears also that if the rough-grinding material is too coarse, the mirror, after "roughing out", is not spherical, but has considerably more curvature in the center. If a finer grade of emery than "1½" is used, the rough-grinding is much prolonged.

About 10 pounds of the "1½" emery will be required for the "roughing-out" of the mirror. The amount required, of course, depends on the diameter and focus of the mirror, and it is not to be expected that the process should be as rapid as in the case of a mirror of smaller size. The depth of the center of my first 9 in. mirror is about 1-12 in., the focus being 63 in., and it is obvious that as the depth of the mirror in the center varies as the square of the aperture, the focus being constant, the time being taken to dig out a mirror of large diameter is much greater than that required for one of smaller size. For the fine-grinding, emery of No. 46 grade was used first; when the curve became nearly spherical, emery of No. 150 grade was employed, then washed flour emery; after which I prepared the finer emeries by processes to be described later. The amount required for the 9 in. mirror was as follows: No. 1½, about 10 lb.; No. 46 about 2 lb.; Nos. 120 or 180, or anything of about that fineness, about 2 lb.; washed flour emery about 6 lb., though more may be required if the later stages of fine-grinding have to be repeated.

The exact grade of emery required for each stage is not very important. For example, an equally good result could be obtained with emery of say, 1½, 80, 180 as with 1½, 46, 180, the main point being to insure a steady diminution in the size of the grain. There is no necessity to use many different grades; in fact, Dr. Common used sand 150, and worked flour in succession. I quote from a letter received from him about two years ago.)

I will defer any consideration of polishing material till later. Meanwhile I would impress upon the would-be beginners in the art the necessity for patience in each stage of the proceedings. I can speak from experience that more trouble is caused by hurry and impatience in going from one grade to the next than by anything else. "The greatest thing in mirror-grinding is to get a good surface before polishing." (Dr Common.) And I have found much reason to believe in the truth of the statement. Every stage of the work must be thoroughly done, and 'More haste less speed" is never truer than in this delicate and fascinating art.

ROUGH GRINDING.

In order to hold the mirror comfortably and to avoid touching it with the fingers during fine-grinding, I obtained a disc of hard wood 6 in. in diameter and ½ in. thick with a handle 1½ in. thick and 3½ in. long fixed in the center. The glass disc was smeared with turpentine, and a pool of melted pitch nearly as large as the wooden disc was poured on, the glass having been previously roughly levelled. I strongly advise the would-be speculum worker never to omit the precaution of first smearing the glass with turpentine. I omitted it once, with the result that when the rough-grinding was nearly complete and I was lifting the mirror off the tool, I had the mortification of seeing it drop on a brick floor from a height of some four feet and, of course, on the "buttered side ". Result, a chip 2 in. square out of the face and a new disc required. If, however, the glass is smeared with turpentine, there is little fear of such a catastrophe.

Here a word concerning pitch—which will be a good friend or a bad enemy, according as we use it well or ill. The pitch was Sweedish pitch, in 2 lb. cylindrical boxes. To get the pitch out, do not attempt to chip it, but cut clean through box and all with a chisel. The wood, which is very thin, will come away from the pitch easily and leave a block. I cut mine into cakes 1 in. thick and melted them in an iron ladle over the kitchen range. There should be no solder in the vessel used, and a long handle and spout are convenient; but, before all things, do not melt the pitch over an open fire, or in any place where it or its vapor can possibly come in contact with the flame. This warning has been often given before, but it is most important if danger of fire is to be avoided. Having got a pool of pitch about 5 or 6 in. in diameter, place the wooden disc on it without pressure and move it about until the wooden and glass discs are concentric; then press down firmly and leave to cool. It is important that the handle should be accurately centered; this can be tested by rolling the disc of glass along a table and seeing whether the handle rises and falls or is apparently stationary. This adjustment is of some importance, as it ensures correct centering of the concavity.

Provide a flat, broad-bladed knife (a putty-knife, for instance), a old sponge, and a basin or bucket of water, (warm for choice).

Wet both tool and mirror thoroughly and sprinkle the tool evenly and closely with the coarse emery. A few drops more water from the sponge will about give the amount of moisture required. It is impossible to say on paper how much emery is required for each "wet" or how much water. This is a matter for experience. If too little water is used the grinding is stiff and unsatisfactory. Too much water or too little emery will cause most of the grinding material to be driven off the tool. Too much emery will give rise to a thick mud, which will slow down the grinding.

Having placed the mirror (or what will be the mirror) on the tool, grasp the handle with both hands, the fingers lying across the disc of wood and reaching to its further edge. Work the mirror to and fro with long, straight strokes, no side motion being given; keep the mirror revolving to the right, or left, as may be convenient, by working the fingers along the edge of the wooden disc, and at the same time walk around the cask, in either direction, so as to get around about once in 20 or 25 strokes. The exact speed is immaterial, but the motion should be continuous. All this will become quite mechanical after a few minutes' work. It will probably be found that a great deal of emery will be driven off the tool; but it can all be collected with the knife and used again, so there is not much waste. The noise made, if the emery is doing its work properly, should be considerable, and it will gradually reduce as the emery wears down. When the mirror glides over the tool nearly silently it is time to put on a fresh "wet". The mirror is slid off the tool—a band being kept under it to avoid accident—and sponged over, a fresh lot of emery is evenly sprinkled over the tool, a few drops of water added from the sponge, and the work proceeds as before. As a rough guide to the quantity of emery required for each wet, I may say that for a 6 in. mirror I used about as much as would go on a crown piece, heaped up; but this is only a rough idea of the quantity. After every five or six wets the speculum and tool should be thoroughly washed with the sponge.

Before this has been going on long a straight-edge placed across the mirror will begin to show "daylight" in the center, and we must begin to think of some way of testing the depth of the curve. A plan often recommended is to make templets in glass or zinc by means of a bar cut to the radius of curvatures required and used as a long beam compass, the glass or zinc being ground smooth after cutting. A plan I got from a back number of "Ours" and which proved very accurate and simple, is as follows: Find out by measurement how thick a pile of, say, 100 sheets of writing paper is

(I used glazed paper which proved to be exactly 200 to to the inch). Dividing by 100, or whatever the number is, we get the thickness of one sheet; in my case, .005 in. Prepare a series of strips of this about ½ in. wide; then if a straight edge of steel is placed across the center of the mirror and strips of paper placed under its center until it just turns about the center rather than about one end, the depth can be easily arrived at by counting the number of strips required. The depth required, the diameter of the mirror being D and the focus aimed at F, is given by the formula $\frac{D^2}{16F}$

Thus, for a 9 in. mirror of 63 in. focus we have the depth in the center $= \frac{81}{16 \times 63} = .08$ nearly, for a 6 in. mirror of 60 in focus $\frac{36}{16 \times 60} = .0375$, and so on.

It is worth noticing that if the focal length of the mirror is made eight times its aperture, the depth required in the center becomes $\frac{D^2}{16.8D}$ or $\frac{D}{128}$; and if the focal length of the mirror is made ten times the aperature, it is $\frac{D}{160}$. Thus a 9 in. mirror of 6 ft. focus would have a depth of 9-I28 or 1-14 nearly. I am assuming that the reader has not got the chance of copying an already-worked mirror. If he has the following will be found very simple. Provide a piece of wood (hard for choice) 6 x 1½ x ⅝ in. Drive two 1½ in. wire nails through one end, side by side, and one through the other end, or use screws, it is quite immaterial, so as to form a long isoscles triangle. Through the center pass a screw about 2 in. long. This will form a rough sperometer, which, if not much use for measuring the depth of a curve, is capable of testing with very considerable accuracy when a certain curve is obtained. Place it so that the points of the end screws rest on the center screw until the whole just turns about its center rather than one end. When the rough sperometer is transferred to the mirror being made, the curve thereof is known to be correct when it just turns about its center as before.

When the rough-grinding is carried so far that the depth of the mirror in the center is as required, it will probably be found on testing with the spherometer that the center is somewhat more curved than the parts nearer the edge; this will disappear in the fine-grinding, but if a definite focal length is required, it is advisable to go on rough-grinding a little more, as the effect of the fine-grinding, in my hands, at least, is to slightly lengthen the focus.

The stroke in rough grinding may be as long as can be given without the center of the mirror going beyond the edge of the tool. If the mirror lifts, in consequence of a tool long stroke, chipping is to be feared. A certain amount of pressure with the hands is permissable but if too much is applied, the emery is liable to be driven off the tool.

THE USES OF HIGH SPEED STEEL.

The writer has taken a good deal of interest in the method of using, treating and grinding high-speed steels. The first thing is to make up one's mind as to the quality or kind of steel to use, which means to be satisfied with the steel which has been found to work best in one's own shop. This has been a difficult matter for superintendents and foremen to decide, because it is so hard to discover the best way to determine which steel will do the most work, and experience has taught most of us that any of our high-speed steels, when properly treated, will do considerably more work than the machine is capable of.

I do not think it advisable to have too many different kinds of stock in the works; results depend entirely upon the way of forging and treating the tool. If the tool maker is familiar with one or two grades of the best high-speed steel, and the quality is found satisfactory and bringing about the best results that the machines can stand up to, these are the steels that should be adopted. Each of these steels must be treated differently, and if the tool maker succeeds in treating one grade properly and understanding it thoroughly, it means much time saved and better results in the shop.

In introducing the use of high-speed steel in a shop, like everything else that is to be a success, one must start right. That is, the work should be undertaken by some responsible person—superintendent, foreman or speed boss; in other words, the man who is responsible for the work turned out in the machine shop. All tools, of course, have some particular way of treating, which should be understood by the person in charge Now, it is "up to the forger". The person in charge should see that the tool has its proper treatment. When the tool is finished and the superintendent or foreman is satisfied that it has been properly treated in accordance with directions, it is ready for grinding and for making a test. It should be ground on a wet emery wheel, and care taken to heat the tool just so it can be touched with the fiugers.

The tool once ground and ready to do the work, the question arises: "What lathe, planer or machine are we going to put it into?" In most cases when a new tool is tried it is put in a lathe to do turning. So, naturally, the superintendent or forman would pick out the best lathe that was in the shop—i. e., the lathe that was considered to have the most power. Being now ready to make the test, it is generally tried on steel; that is considered by most superintendents and foremen to be the severest test to make. Take a piece

of steel of almost any diameter and of the quality most used in the shop, and prepare to take the cut. It seems to puzzle most every foreman to know just what to do and where to start. I speak now of what I have seen, and of the men who are sometimes sent by the steel makers to demonstrate the use of their steels. I think the proper way is to get at least one dozen shafts of a standard size that are used in the regular line of product, and to first look up the exact time it took to finish or rough off the previous lot; then to determine about what percentage of time would be considered a fair gain to warrant adopting the steel, based on the price per pound of the steel being used. Let it be based at 25 per cent, which I find in most shops can be accomplished, and the lathe be speeded up faster than when the last lot was turned, starting with the same feed, and about the same cut, which almost any lathe will stand. The superintendent finds, after he has roughed off about two or three pieces, that the tool seems to stand up all right. The next step is to find out about the speeds and feeds. The first thing is to increase the feed with the same speed the machine is running at. In most cases which I have seen, after the tool had traveled a certain distance, the cutting edge would break or crumble, and the foreman would say: "Just as I expected. All this high-speed steel will do the same thing!" forgetting he had just been doing over 25 per cent. more work than ever before, without the least bit of trouble.

Now the tool is taken out and looked over, it is found that a portion of its cutting-edge has been broken off. Here is where most foremen make a mistake; they take the tool back to the forger or tool dresser to have it redressed and treated over. If it is only broken off slightly and can be ground, even if it takes ten or fifteen minutes to grind, it should be done by all means. My experience has taught me that it will prove a better tool than before; but care must be taken not to overheat in grinding.

The tool is now put back in the lathe, which is started again; and generally, to one's astonisment, it will be found that the tool will stand up all right. One should not be too anxious to break the tool again (!) but should turn up two or three more pieces with an increase of feed, keeping a record of the time it takes to turn up each piece. Once convinced that the tool will stay up all right with the increase of feed, the foreman can increase the speed one step on the cone. About the time this is done it is found either that the belt slips, the lathe is stalled, or the countershaft will not drive. (It is my opinion that in most all machines which have been built up to a year or so the countershafts are not strong enough in comparison with the machine tools.) Now, no doubt if these things had not occurred the tool would have done better; but in this case reduce the speed and finish the twelve shafts which it will probably be found can be done without grinding the the tool. When the shafts are all roughed off and finished, the foreman will find, to his great astonishment, that by actual time the lathe has produced over 25 to 40 per cent more work than ever before. I allude to the lathe using most all ordinary tool steels.

At this point it in up to the superintendent to see just where he is at, and he finds in looking aroun' his shop that there is hardly a machine that he can't speed up; but he also finds that the speeds on the countershafts are all too slow. This means that he has either got to increase his speed by increasing the main line, or buy new pulleys to increase his countershafts. In most instances it is advisable to increase the speed of the countershaft; but by doing this he generally finds that the countershaft will not stand the speed. If the machines are not too badly worn out, and he is satisfied that he can get at least 25 per cent. more work out of the tool by increasing the counterspeed, by all means let him get a new countershaft and treat each machine this way.

No doubt the readers of this article will know the results that some of us have arrived at in the last two years. In regard to cutting speeds and feeds there has been and always will be difference of opinion, and it is almost impossible to determine the right feeds and speeds, whether it is for steel or cast iron, and for the operations of planing, turning or milling. The work varies so in different shops; that is, regarding the construction of different pieces, the amount of metal there is to remove from each piece, and how accurately the work has to be done.

There is no doubt in my mind that the makers of high-speed steel have awakened the management of different shops, and it is surprising the amount of work which can be accomplished even with the old machines, with very little redesigning. There is no question but that the machine shops which do very heavy work have not the necessary power for the use of high-speed steels, as the power should be used if the machines are old ones. Referring again to the question of grinding, I wish to state that this is a very important factor in the use of high-speed steels. I have seen much damage to the tools, in many instances making it necessary to treat them over, and as we all know, this takes much time. My recommendation for grinding is to let one man grind all the tools and be responsible for them. When a lathe tool or a machine hand wants his tool ground, he simply gives it to the man who is responsible, and gets another the same size and shape, these being always kept ground and ready for service. In this way the tools are kept uniform and ground alike.

In reference to the amount of work that can be accomplished on different machine tools, the writer finds that the feeds have been altogether too fine on most makes of machines up to the time that they were redesigned for high-speed work. Now it has been demonstrated that high-speed steel has come to stay, and we all know that it works better on roughing work than it does on finishing. If most of the product of

the machine department is to be turned, it has come to the point where the majority of work must be ground; and this is the only way to get good and accurate work, especially where the strains of the cut spring the work. Moreover, as it is not necessary to straighten the work to any great extent, it certainly means a great saving, as many of our readers know. The writer is not a builder of grinders, but merely speaks of the saving it has been on his own work.

Below is a fair average of the speeds that most any good make of lathe, planer, drill press or radial, ought to stand when using high-speed steel. Every lathe has a face-plate about the diameter of the swing, or very near that. Take the periphery speed of same by feet minute; the use of a Warner cut-meter will give you speeds instantly. This is one of the handiest little tools that can be obtained, and no machine-shop is complete without it. The speed must be taken with the belt on the largest step of the cone, with the back gears in. The speed of the following sizes of lathes, taken from a large faceplate with the slowest speed, I find to work very well, and considerable saving has been effected on old lathes. Of course, the feeds will have to be determined by the amount of power available:

LATHES.

14 in.	swing;	slowest	speed	with	back	gears	in,	100	ft.
16 "	"	"	"	"	"	"	"	90	"
18 "	"	"	"	"	"	"	"	85	"
20 "	"	"	"	"	"	"	"	75	"
24 "	"	"	"	"	"	"	"	65	"
30 "	"	"	"	"	"	"	"	60	"
36 "	"	"	"	"	"	"	"	50	"
42 "	"	"	"	"	"	"	"	30	"

Larger lathes in proportion.

PLANERS.

20 by 20	travel	of	cut	40 ft.
24 by 24	"	"		38 "
36 by 36	"	"		35 "
48 by 43	"	"		30 "

Larger ones in same proportion.

If you have the power in your planers the speeds ought to work on soft steel as well as cast iron.

High speed twist drills, drilling cast iron, ought to drill the following, if you have the power and feeds:

½	in.	diam.,	speed	500	r. p. m.,	3½	in deep in one min.
⅝	in.	"	"	400	"	2⅝	in. " "
¾	in.	"	"	335	"	2¼	in. " "
⅞	in.	"	"	290	"	2⅛	in. " "
1	in.	"	"	250	"	2½	in. " "
1⅛	in.	"	"	220	"	2⅛	in. " "
1¼	in.	"	"	200	"	2	in. " "
1⅜	in.	"	"	185	"	1⅞	in. " "
1½	in.	"	"	175	"	1⅝	in. " "

Larger ones in proportion.

These speeds are all based on a periphery speed of 65 ft. per minute. High-speed drills have done somewhat better than this, however; but, taking into consideration the time of grinding, I find that this speed is a good average during a day's work.—"Machinery."

A classification of electric motors shows them to be divided into groups according to their winding and the character of the current employed to operate them. The direct current is used for motors wound as follows: Constant current series-wound motors, constant potential shunt-wound motors, constant potential differentially wound motors. Each of these types is distinct as far as its winding is concerned, although the last is a combination of the first two—that is, shunt and series winding. Series-wound motors are employed on direct current circuits which supply a constant potential; they are used in high tension arc light constant current systems and in street railway 500-volt constant potential systems. The shunt-wound motor is used for stationary work, such as the running of machine tools, printing presses, etc.

Experiments in long-distance overland space telegraphy were made last year, says "Cassier's Magazine," and in the United States signals were transmitted a distance of about 300 miles between Chicago and St. Louis. There appears to be no crying demand, however, for a wireless telegraph service for public use between large cities, even if the entire practicability of the sytem for long distances overland had been satisfactorily demonstrated; but the employment of this beautiful system, which has not yet ceased to be wonderful, between ships at sea and ships and the mainland, and between points divided by sea or lake, where the use of cables is not economically practicable, is steadily and rapidly increasing. Among the more recent important instances of this nature are the five Marconi stations on the river and Gulf of St. Lawrence, which cover a territory of nearly 1000 miles, and the De Forest Stations at Bocas det Terro, Panama, and Port Limon, Costa Rica, seventy miles apart.

A recent improvement in micrcscopy utilizes an entirely new principle of radiance. When ordinary sunlight is analyzed by a prism, the observer sees all the colors of the rainbow, there being at one end of the series a violet band and at the other a red one. The rays emanating from the former are shorter than the others. Out beyond the visible violet rays are others having a still shorter wave length, but ordinarily unseen. Glass obstructs them, but a prism of quartz transmits them. These "ultra violet" rays have a high photographic value. The astronomer is thus enabled to obtain records of lines in the solar spectrum which he cannot see. Some of the Jena experts have proposed to substitute quartz for glass in the train of lenses interposed between the arc light and the specimen, and also in the objective used for examination. Thus the visible light is reinforced by invisible light, the latter being particularly useful for obtaining a photograph of a specimen. The plan has the additional merit that the staining of a specimen before examining it would be unnecessary.

A READING STAND.

JOHN F. ADAMS.

Many readers of AMATEUR WORK are undoubtedly studious and given to reading, and when such reading is from a large and heavy book, fervently wish for some kind of supporting device wherewith to make easier the holding of the book. This is especially true when, tired from an arduous day's work, one desires to lie on a couch and rest, and at the same time to read. While visiting a friend recently, whose ingenious mind is always planning, and skillful hands making, some labor saving fixture, the stand here described was exhibited and pronounced by the owner to be most satisfactory furniture he had added to a somewhat large collection of homemade work. The illustration clearly shows its general makeup. It can be made of whitewood, gumwood, oak or any except very soft wood.

The lumber bill is as follows:

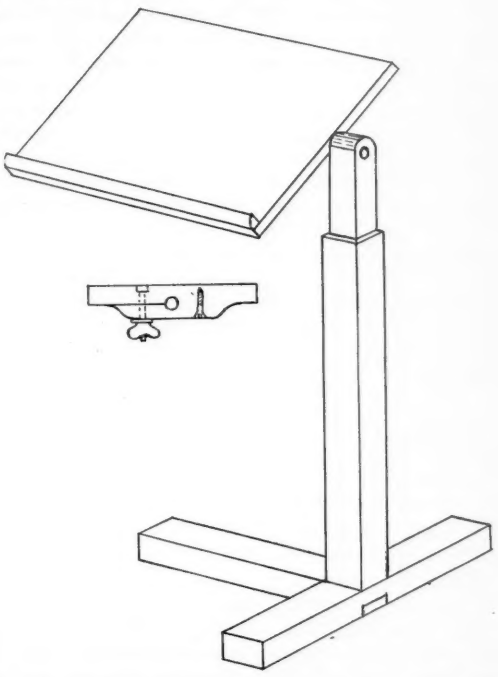
1	piece	4 ft. long and 1¾ in. wide, ½ in. thick.
1	"	7 " " " " " " 1¾ x 2¾ in. "
1	"	4 " " 2¾ " " " " 1½ in. "
1	"	18 in. " 15 in. " " ¾ in.
1	"	18 in. " " 1¼ in. round curtain rod.
1	"	½ in. moulding.

The T frame at the base is made of the 1¾ x 2¾ in. stock, the top of the T being 18 in. long and the extending piece, 16 in. long, with halved joint. A mortise 1½ in. square is made through the center of the joint to receive the tenon on a piece of the same stock, 6 in. long and 1¾ in. square. The tenon made on this latter piece is very firmly wedged into the mortise, and also glued for additional strength.

The barrel, 24 in. long, is made of the ½ in. stock, measuring inside 1¾ in. The joints should be glued and nailed, planing off, when the glue is dry, to secure a good, smooth surface. When finished it is firmly nailed at the bottom to the short piece projecting from the T base.

The post should have a snug fit inside the barrel, and yet slide therein without binding. It is 24 in. long and 1¾ in. square, which is secured by sawing off one edge of the 1¾ x 2¾ in. stock. The top end is rounded off, as shown. A hole is bored not quite through the top, and centering 2 in. from the top, for the end of the piece of 1¼ in. curtain pole. If this size cannot be obtained, use 1 in. pole.

The table is a plain board 18 x 15¾ in., with two supports, screwed and glued to the under side of the shape of the supports, as shown in the illustration. They are cut out of the 1¾ x 2¾ in. stock, and are 12 in. long. Holes are bored at the center to give an easy fit to the rod. Slots are also cut from one end to the center of the holes, and bolts with butterfly nuts fitted, so that by screwing up the nuts, the supports will bind on the rod and hold the table in any desired position. It is also well to put screws through the ends opposite the slots to prevent their splitting at that place. Washers should also be placed under the nuts. It will be noted that to adapt the stand to either side of a couch or bed, it is only necessary to take off the table, turn it around and replace upon the rod.



To adjust the height of the post, 1 in. holes 3 in. apart are bored in both barrel and post on the side from which the table extends, but not through the outer side of the barrel. The lower hole is 12 in. above the base. A wooden pin is then made to fit the holes, with the inner end pointed for easy insertion.

In addition to the uses first mentioned, this stand is very handy as a medicine or food table beside a bed for case of sickness.

"Acid metal" or "lead bronze" is a durable alloy which can withstand the corrosive action of mine water. It is, therefore, suitable for machinery employed underground. Its ingredients are: 75 per cent. copper, 15 per cent. lead, 99 percent tin, and 0.10 per cent. phosphorus.

MARINE GASOLINE MOTORS.

THEIR DESIGN AND OPERATION.

By Courtesy of the Brooks Boat Mfg, Co.

Most manufacturers of these motors claim that theirs is the best, most reliable motor on the market, and in support of this claim give a detailed description of the different parts and manner of construction; explain the principle upon which the motor operates; show illustrations of the different parts, etc.

All this would be perfectly proper and of value to those seeking information were it not inferred that each point and principle described was a special feature of their particular motor and of no other. To those unfamiliar with them, this result is a confused idea that there are numerous kinds of these motors involving entirely different principles of construction and operation. It is with a view to correct this erroneous impression and at the same time give a true understanding of the principle and operation of all gasoline motors that the following explanation is given. The subject is therefore taken up only in a general sense and does not apply to motors of one make any more than it does to those of another.

PROPERTIES OF GASOLINE.

Gasoline alone will ignite but not explode. The mixture of vapor formed by gasoline and air will ignite and explode. When this vapor is compressed it will ignite easier and give more power to the explosion. The power of all gasoline motors is derived from the impulse given by the explosion of the compressed vapor.

MOTOR CONSTRUCTION.

Marine gasoline motors consist of one or more water jacketed cylinders with an immovable head at the top end, and a movable piston inside that is connected by a rod to the crank shaft. This is the foundation of all motors.

The conditions are that in operation the combustion of the vapor produces heat; that the cylinder must be kept cool for proper lubrication; that a proper mixture of vapor must be supplied to the cylinder; that this vapor must be compressed by the piston; that the compressed vapor must be ignited; that proper lubrication to all parts must be had, an that all of these must be automatic, positive and under control.

IN OPERATION

The cylinder is kept cool by water circulating through the water-jacket of the cylinder. The water is circulated by a pump attached to the shaft. The vapor is supplied by the carburetor or vaporizer, devices that properly mix the gasoline and air. The vapor is drawn into the cylinder by the piston, which in this connection acts as a pump. The charge is compressed by the return stroke of the piston, and when so compressed is fired by an electric spark. The explosion of the compressed charge imparts an impulse to the down stroke of the piston, a portion of the energy being stored in the momentum of the flywheel. This stored energy completes the revolution and compresses the next charge. The pistons and connections are lubricated by sight feed and compression oil cups, using for the gas-engine cylinder oil.

TWO AND FOUR CYCLE MOTORS.

The gasoline motors in general use operate as stated, on the one principle. They vary only in the application of the same principle. There are two important variations. First, in the number of revolutions made to each impulse. Second, in the igniting device. With reference to the first, a motor that makes one complete revolution of the shaft to each impulse is called a two cycle. (The piston makes two motions—up and down.) A motor that makes two complete revolutions of the shaft to each impulse is called a four-cycle. (The piston makes four motions—up, down; up, down). There are arguments in favor of and against both types, which we will state and comment on.

THE TWO CYCLE MCTOR.

The two cycle motor having an impulse to each revolution will have twice as many impulses as a four cycle. This results in a more even distribution of the power, hence less vibration. To state this in another way—a four cycle, to develop the same power on the same number of revolutions, would require twice as strong an impulse, as it would have but half the number of them.

The two cycle has this objection—that the compressed charge is not as pure, and that a slight portion of it is wasted. Theoretically the impulse given by the explosion takes effect when the piston is at the top of the cylinder, driving it down. Near the bottom of these is the exhaust outlet, and the other is the inlet for the new charge. As both of these are practically open at the same time, a slight amount of the new charge may pass through without being compressed, and as the new charge is taken in at the same time that the old one is exhausted, a part of the latter may not escape. Hence, theoretically the two cycle has not as pure a mixture as the four cycle. This objection is partly remedied by the deflector, which is a plate on top of the piston that deflects the new or entering charge up and away from the exhaust port.

FOUR CYCLE MOTORS.

The four cycle cylinder has both the intake and exhaust openings at the top of the cylinder, and they are

operated automatically by valves instead of by the piston as in the two cycle. To explain, we will follow the operation. Commencing with the piston at the top of the cylinder, the down stroke of the piston draws in a charge, the inlet valve being open and the exhaust closed. At the end of the down stroke of the piston the inlet valve closes and the up stroke of the piston compresses the charge, which is exploded driving the piston down. At the end of this down stroke of the piston the exhaust valve opens and the up stroke forces the exhausted charge out. At the end of this up stroke the exhaust valve closes and the inlet valve opens, ready to repeat the operation.

The argument in favor of the four cycle is that the cylinder is better cleared of the exploded charge before the fresh charge enters. This is not entirely true for the reason that the piston does not travel clear to the top of the cylinder, therefore the compression or firing chamber may still retain a portion of the exploded charge.

This is the most important factor in the operation of the motor. There are several forms of ignition in use. First, the hot tube method, a device but little used by manufacturers in this country except for stationary motors using natural gas, so we will not trouble to describe it.

All electrical sparking devices are supplied with electricity, either from the cells of a battery or a small dynamo. As the latter will not generate the current until in motion it is always necessary to have the battery to start the motor. After the motor is in motion the bttery is switched off and the current supplied by the dynamo only. This results in saving the battery and is in all ways most satisfactory. This is particularly true in reference to the larger motors.

The electrical sparking devices may be divided into two classes. The first class consists of the the jump spark. The second class may be classified under three heads, the make and break, the wipe spark and the hammer break.

The jump spark is becoming the most popular method and is fast superseding all the others for two cycle motors. The jump spark mechanism consists of three or four dry cells, an induction coil with a primary and secondary winding fitted with a vibrator (commercially known as a spark coil), a spark plug and a suitable device attached to the shaft for making the circuit. The spark plug screws directly into the firing chamber and contains the points or terminals. These are properly insulated and at their end are not more than 1-16 inch apart. Without technical explanation it may be stated that when the circuit is formed the excitement of the coil causes a strong spark to jump between the terminals of the spark plug within the firing chamber.

The points in favor of the jump spark are less moving parts, positive ignition, simplicity of mechanism and no moving parts within the firing chamber.

The objection to the jump spark is that the space between the terminals is liable to become fouled by soot if the vapor is too rich in gasoline or by oil if too much lubrication is given the cylinder. However, the objectional conditions seldom occur after one becomes familiar with the requirements of the motor, and when the points do become fouled the spark plug may be instantly removed and cleaned.

The second class, the make and break, wipe spark and hammer break all operate on the same principle with numerous different mechanical methods of operation. Therefore, we will not attempt any definite description other than to state that they consist of two electrodes or terminals within the firing chamber. One of these is stationary and one movable. The spark is given by the separation of the terminals. When the points lap by and wipe together it is called a wipe spark; when separated by a spring it is called a make and break, and when separated by a blow from a projecting arm it is called a hammer break. Of the three, the make and break is most in favor. The objection to all of these is the mechanism required and its liability to get out of order; that the firing chamber is twice punctured by the electrodes; that it is difficult to keep the joint tight where the moving electrode enters the firing chamber; that it is hard to lubricate—this for for the reason that the pressure within tends to force back the oil; that the points of the terminals wear out and are apt to become fouled or gummed with oil and soot.

Although our experience is in favor of the jump spark, especially with the smaller types of motors, we must, in justice say that some of the make and break devices give splendid satisfaction, particularly when used on the larger multiple cylinder motors.

VAPORIZING THE FUEL.

There are in general use two devices for mixing the gasoline and air to form the vapor. These are the vaporizer and the carburetor. The vaporizer is a device that mixes the gasoline and air by the operation of the motor, that is, the up stroke of the piston acts as a pump and draws in the supply of air. This mixes with a jet of gasoline and passes into the base. The down stroke of the piston compresses this vapor so that when the port opens it passes into the firing chamber above the piston.

The gasoline feed of the vaporizer is regulated by a needle valve, and the air supply is usually taken through a cheek valve. The vaporizer mixes sufficient vapor at each cycle for the charge only.

The carburetor produces the vapor by bringing a quantity of air and gasoline into contact, either by drawing the air through a reservoir of gasoline or over its surface. The carburetor has a supply of vapor in reserve. Both the vaporizer and carburetor operate better in warm than in cold weather, as the expansion of the gasoline greatly reduces the temperature. This is overcome by heating the air supply. A simple heating device is to place a perforated collar over the exhaust pipe, thus making a hot air chamber and con-

necting this with suitable piping to the intake air valve.

CONTROL.

As the marine motors are all comparatively high speed, the piston travel is very quick, and in order that the thrust may be given to the piston the ignition must take place at such a point as gives the best results. Regarding this we must consider two points—the speed of the piston and the time required to expand the charge after it has been ignited. We will make this point clear, as it is of importance to the amateur operator. In the first place, the sparking device on all motors is or should be regulated by a lever under the operator's control so that by manipulation of this lever the spark (time of ignition) may be advanced so as to cause early ignition, or retarded so as to cause late ignition at will. Now supposing the motor is turning very slowly (as when cranking it) the lever should be set so as to fire the charge just when the piston is starting on the down stroke. But as the speed of the motor increases the travel of the piston becomes so fast that it does not receive the impulse, that is, the charge has not had time to fully expand while the piston is on the downward stroke, therefore the time of ignition must be advanced to that point which will give the greatest force of the expansion to the down stroke of the piston. This results in the ignition taking place while the piston is on the up stroke; that is, while it is still compressing the charge.

The regulation of this is a very simple matter and is, of course, dependent upon the speed or number of revolutions the motor is making. The operator merely manipulates the controling lever.

By advancing it he will increase the speed up to the maximum point. By retarding it he will decrease the speed or check down the motor.

It is by this manipulation of the spark that the motors may be made to run either way. After one becomes thoroughly familiar with some of the smaller two cycle motors, they can be slowed down and reversed without stopping, through a proper manipulation of the spark control.

When the motor is to be run under check for any length of time, the supply of vapor must also be reduced.

CONCLUDED IN THE JULY NUMBER.

THUNDER STORM INDICATOR.

OSCAR F. DAME.

Every student of wireless telegraphy is familiar with the story of the first coherer, with which electrical disturbances in the air were noted by the operation of a relay and the ringing of a bell.

This same coherer principle enters into the receiving apparatus of many wireless systems. While the scheme is an old one, there is still an excellent opportunity for experiments in this line, and apparatus built according to the accompanying specifications should be a fairly accurate recorder of the excess of electrical impulses in the air which usually precede a thunder storm.

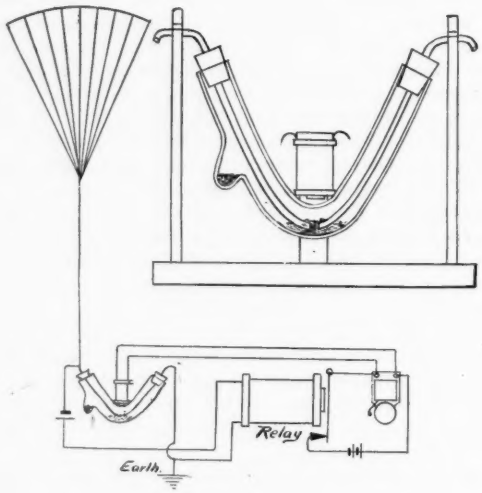


Fig. 1 represents a coherer designed especially for receiving high voltage disturbances, and immune from arc light and trolley spark waves. The glass tube may be purchased at any drug store for a few cents. The diameter of the tube is about ¼ in. The tube is heated over an alcohol or gas flame and bent to a V form. A sack is also drawn out on one side near the top to hold extra filings. The two electrodes are of polished heavy copper wire.

This coherer is not exhausted, and the amount of filings at the electrodes may be regulated by drawing from the supply at the sack. The filings are of clean cast iron, as fine as can be made. Any relay suitable for wireless telegraphy, many of which have been described in back numbers of AMATEUR WORK, will operate with this receiver. The electro-magnet is about the size of one coil in an electric door bell, but should be wound with finer wire, No. 24 being a good size. The purpose of this magnet is to serve as a decoherer when the relay operates. The coherer should be supported by two wooden pillars mounted on a base-board. These can be made from meat skewers. A 2½ in. door bell serves for a signal in place of a sounder. The aerial wire and ground wire should be constructed the same as those of a simple wireless circuit.

To test the purity of turpentine, drop a small quantity on a piece of white paper and expose to the air. No trace will be left if the turpentine is pine; but if it contains oil or other foreign matter, the paper will be greasy.

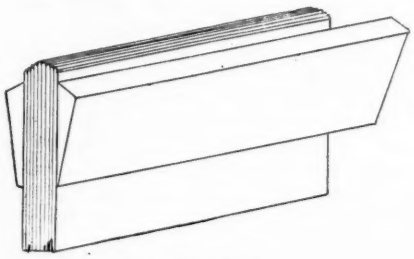
BOOK-BINDING FOR AMATEURS.

WINTHROP C. PEABODY.

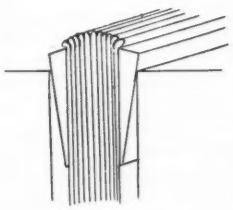
VI. Rounding the Back.

The sewing completed, an examination should be made to ascertain that all sheets, plates, etc., have been securely fastened. The next operation is the addition of the end papers, or what are commonly termed "fly leaves". These are the blank pages to be found at the front and back ends of all bound books. In the finer binding a white paper similar to that of the book, but slightly thicker, may be used, or a tinted paper, if desired.

When folded once in the middle the size should be that of the book. The fold should be pressed down with an ivory, thin glue spread along the edge of the fold and then placed evenly on the book, a board and weights being placed over it until dry. But little glue should be used, just enough to firmly fasten in place along the whole edge.



READY FOR LAYING PRESS.



AFTER BACKING.

It will be necessary at this point to distinguish between grades of work, as much labor can be saved on books which are bound largely for the sake of keeping them in permanent shape, and without special desire to secure a fine appearance. With books of this class we can at once proceed to have them trimmed on the paper cutter of some printer friend, first having "jogged" the back perfectly flat, and marked in pencil on the top page, lines showing where the knife is to cut.

With books of more value and finer bindings, this trimming is done "in boards," or after the boards have been attached and other work done, and this method will be described later.

After trimming, the backs are "rounded up," which also has the effect of giving the front a concave form, making a better appearance than when flat, and also easier to turn the leaves when reading. This operation is one requiring some experience and skill before it can be done quickly, but with the exercise of patience and care, no great difficulty will be met with. The experienced binder will partly work up the back with a few turns of the hand, but the beginner can do nearly as well if he will provide himself with some strips of wood, the upper surface of which has been rounded to the arc of a circle with diameter of about twice the thickness of the book. Holding the book at the ends with both hands, jog the back on a flat, solid surface until it is even, turn the book over and jog the front edge on the rounded surface of the rounded strips. This will give the back the desired curvature, using care that the curve is even throughout.

Holding the book, with the back rounded, in the left hand, a backing board is placed on one side, with the edge of the board about $\frac{1}{8}$ in. lower than the back. Another backing board is then placed on the other side of the book, and book and boards placed in the laying press or vise, which is screwed up tight, as shown in the illustration. Backing boards can be made from cyyress clapboards of even grain, the thin edge being cut off and the thick edge beveled.

The back of the book is then covered with thin glue, applied with a brush, working the glue into the back sufficiently to hold it securely and yet not enough to run down into the leaves and make the back unduly stiff. The glue is then allowed to dry until it is almost hard, or until all "tackiness" has disappeared and will not stick to the hammer. With a flat-headed hammer, much like those used by shoemakers; the edges are then hammered outward a little at a time and working all along the edges until they are bent to the extent of the thickness of the boards used for the cover. The motion given the hammer is much like that used in heading over a rivet, but care must be used not to strike with the edge or the paper will be cut. It must also be done gradually, or creases and breaks will result. A little practice will soon show what is needed.

The backing being completed, apply another very thin coating of glue, then put on a strip of thin, tough paper, of a size to just cover the back, except about $\frac{1}{4}$ in. at each end. If unable to obtain the special paper used for this purpose, a thin, strong manila paper will serve. Again apply thin glue to this covering of paper and put on the strip of backing cloth, the size being such as to come within $\frac{1}{4}$ in. of the ends of the book and projecting to either side from 1 to $1\frac{1}{2}$ in. according to the size of the book. When the glue is quite dry, remove from the press, for further work, which will be described in the next chapter. The process here given is that suitable for binding of magazines, or where only plain, rapid work will answer. The backing of books of a more valuable and attractive character is done in a slightly different way, to be taken up in a subsequent chapter.

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TO ADVERTISERS.

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JUNE, 1905.

The demand for sets of bound volumes has been so large as greatly to reduce the supply of Volume I. Those desiring a complete file of the magazine will be obliged to send their order at an early date to ensure obtaining all the volumes. It is very doubtful if any more of Volume I. will be bound, as several numbers are out of print, and the expense of reprinting is too heavy to warrant this being done to the extent necessary to make up a complete volume.

The vacation season is at hand. To those of our readers who are fortunate in having two or three months which can be utilized as desire dictates, a word of suggestion is offered. Instead of the usual period of idleness or sport, why not lay out a course of study in some useful and practical line, such as visiting the electrical power houses, machine shops, or other large industrial plants in which one may be interested, in this way acquiring a fund of useful knowledge which the future may show to be of direct personal profit.

In addition, a course of reading along lines in which one is interested will serve to fill in many an idle hour and result in greatly increased knowledge of something of practical value. Constructive work of an electrical or mechanical nature is also to be recommended, and those attempting it will find, at the close of the vacation, that they are fully as well physically, and much improved mentally, as though sport or idlenes had been the sole consideration.

An inspector who has just returned from a tour of the buoys on the coast of Nova Scotia reports that the sub-marine bells which have been placed in position, one off Sambro and the other off Egg Island, are working admirably. The bells can be heard at a distance of five miles, as tested by the steamer Laurier, which is equipped with a receiving instrument on which the sound is heard. Submarine telephone signals will be established at several other points on the Nova Scotia coast in the Bay of Fundy and on the Cape Breton seaboard. The department of marine has contracted for a large number of these well-tried and successful aids to navigation and they will be installed as rapidly as possible. It is expected that all steamers running to Canadian ports will soon be supplied with the receiving apparatus which will enable approach to the coast with safety in all kinds of weather. Mr. Prefontaine, minister of marine, made a personal test of the submarine telephones on the Metropolitan Line steamers running between Boston and New York, and he is confident that these bells will be of the utmost value to Canadian shipping.

Fires caused by steam pipes are often very difficult to trace to their source. A large house in New York was not long since burned, and it was found that the fire was caused by a steam drum in contact with wood, with which it was encased. The manner in which a heat of less than scorching intensity sets fire to woodwork is not generally known. The conditions to produce this are, first a degree of heat not less than 212° F.; second, the presence of wood in close proximity to the iron steam pipes; third, the existence of scale or rust on the iron; fourth, varying temperature. The heat drives the oxygen from the iron rust, which then becomes what is known as reduced iron, a finely divided metallic powder of the natural color of iron. The heat necessary to ignite the wood, which is in a tinder-like condition, from its proximity to the hot pipe, is generated in the rapid oxidation of the iron. It absorbs oxygen so rapidly under certain atmospheric conditions of humidity and temperature as to glow for a few seconds, long enough to set the adjoining wood on fire. The greatest caution should be exercised in installing heating systems to allow ample space between steam heating pipes and adjacent woodwork.

THE METAL WORKING LATHE AND ITS USES.

ROBERT GIBSON GRISWOLD.

II. Screw Cutting—What Gears to Use.

Perhaps the one feature above all others that makes the engine lathe so valuable and the "king of machine tools," is its power of screw cutting. By means of the lead screw which is shown running along the front of the bed in the illustration given in Chapter I, the carriage, carrying the threading tool, may be moved along the ways at a predetermined rate, and the groove cut by the point of the tool will have a definite pitch per unit of length.

The lead screw is caused to revolve by a series of gears placed on adjustable studs at the left hand of the lathe-bed. These gears, shown piled one above the other on the floor, are called the "change gears," and bear such a relation to one another that certain standard threads may be cut by their aid, and, by compounding them, many fine and fractional threads may be produced.

The formula for calculating the correct gears to use for cutting a certain thread is interesting, of value, and well worth the time in becoming acquainted with it. All lead screws are cut with a certain number of threads per inch; in small lathes it may be 10, while in larger types the pitch may be 5, 4, or even two threads per inch. Owing to the fact that a split nut has been provided in the apron of the tool carriage whereby the carriage may be moved along the ways when it is closed around the lead screw, this rate of movement may be modified by controlling ratio between the revolutions of the spindle and lead screw.

Suppose that the lead screw has ten threads per inch; one revo ution of the screw would move the carriage 1-10 in.; two revolutions 2-10, a half revolution would move it 1-20, and so on. If we have a piece between the centers upon which we wish to cut a thread of ten pitch, and the lead screw is provided with ten threads per inch, it is evident that if the spindle and screw revolve in unison the tool will be moved along the surface of the piece at the rate of 1-10 in. But perhaps we wish to cut fifteen threads per inch. In this case the lead screw must not advance the carriage so rapidly, but while the spindle is making fifteen revolutions, the lead screw must make only ten, so that the carriage will be moved just 1 in. The ratio of the revolutions, therefore, is 15 : 10 or 3 : 2. Now, if we placed a gear having 20 teeth on the spindle, and another having 30 teeth on the lead screw, the spindle would revolve three times while the lead screw was revolving twice, since $3 \times 20 = 2 \times 30$.

We are now in a position to derive our formula which may be applied to any lathe, and the amateur may make up his thread table for any number of threads within the capacity of the change gears. As we learned above, the number of threads cut depends upon the ratio existing between the revolutions of the spindle and those of the lead screw, and its pitch of thread. When the pitch to be cut is the same as that of the lead screw, the number of teeth in the spindle gear and those in the lead-screw gear must be the same. An idler gear placed between these two gears in no way affects their ratios of revolutions, but simply alters the direction of revolution. Therefore, the Pitch to be cut : Pitch of lead screw : : No. teeth in lead-screw gear : No. teeth in the spindle gear.

The ratios between the two pitches and the teeth of the two gears are inversely proportional. Then

Let p = pitch to be cut.

Lp = pitch of the lead screw.

Gl = number of teeth in the lead-screw gear.

Gs = number of teeth in the spindle gear.

Then $\frac{p}{Lp} = \frac{Gl}{Gs}$, and $Gl = \frac{Gs \times p}{Lp}$

In this formula, three of the quantities maybe either determined or assumed, and by simple proportion the the fourth may be readily found. First determine the pitch of the lead-screw by counting the number of threads per inch; then make a list of every gear that comes with the lathe. By simply substituting the different numbers of teeth in the formula, a table may be readily formed for every possible thread that can be cut by this simple train of gears. This is what is known as simple gearing, and the rule may be expressed as follows:

"Where the spindle gear is either driven on the spindle direct, or on a separate stud that revolves in unison with the spindle, to cut a given number of threads per inch, select a certain gear for this stud; multiply the number of its teeth by the pitch to be cut, and divide this product by the pitch of the lead screw; the quotient will be the number of teeth necessary in the lead-screw gear." Should this number be fractional, which would give a fractional number of teeth and is impossible, select some other gear for the spindle gear and repeat the operation until some gear is found that will give an even number of teeth for the lead-screw gear and one that is contained in the set.

You may readily reverse this process by selecting the gear for the lead-screw, multiply the number of teeth by the pitch of the lead screw, and divide this product by the number of threads per inch which you wish to cut. The quotient will be the number of teeth required in the spindle gear.

If the number of teeth in the gears supplied with

the lathe increase by a constant number, that is, if the smallest gear has 20 teeth, the next largest 24, the next 28, 32, 36, etc., it is readily seen that the constant number by which they vary is 4; multiply 4, or any multiple of 4, by the number of threads per inch in the lead-screw. The product thus found will be the number of teeth in the spindle gear. Then multiply the same constant by the number of threads that you wish to cut, and this product will be the required number of teeth in the lead-screw gear.

It sometimes happens that the various makers of lathes adopt different methods of driving the first or spindle gear. Some place it directly on the tail of the spindle, others place it directly below, driving through a pair of spur gears, while others use a train of gears and alter the ratio of these gears from 1 : 1 to 1 : 2 or 2 : 3, thus making the spindle-gear stud revolve more slowly than the spindle.

This will alter the formula given above to this extent. The apparent pitch of the lead-screw will be increased, and before calculating its gear, multiply the number of threads per inch by 2 if the stud revolves one-half as fast as the spindle, by 3 if the ratio is 1 : 3, or by 1.5 if the ratio is 3 : 2. Then use the apparent pitch of the lead-screw for Lp.

There is one fractional thread that is very often cut, and that is the thread used in pipe work, 11½ threads per inch. It may be interesting to use this example as an illustration in assisting the amateur to understand the foregoing directions. Let us assume that the lead screw has 6 threads per inch and that the number of threads to be cut is 11½ per inch. The gear on the spindle is driven direct and at the same speed as the spindle, and the constant number between the gears is 4. We wish to find the gears for the spindle and lead-screw.

The pitch of the lead-screw is 1-6, and the pitch of the thread to be cut is 1-11½, or 2-23. Reducing these two fractions to a common denominator, we have 12-138 and 23-138, respectively. These two screws, therefore, will be in the proportion of 12 to 23, the denominators of the fractions, and we can assume that the threads to be cut are 23 per inch and that the lead-screw has 12 threads per inch. Multiplying each by the constant 4, we have $4\times12=48$, the number of teeth in the spindle gear, and $4\times23=92$, the number of teeth for the lead-screw. These two gears, therefore, cut 11½ threads per inch, or, since this is the ratio that is to be preserved and not the number of teeth, two gears of 24 and 46 teeth would accomplish the same result, as would 12 and 23 teeth. Should it happen that the stud travels one-half as fast as the spindle, multiply 12 by 2, and this product by 4, which would give 96 as the number of teeth required in the gear on the stud, the gear on the lead-screw remaining the same.

But in a train of simple gearing, such as has been described above, the number of threads possible with a limited number of gears is small. We have, however, recourse to another method which greatly enlarges the number of possible threads and renders it possible to cut threads of an almost infinite number of pitches with a comparatively small set of gears, because the limit to the number is only reached after every possible combination with each gear has been made. This method consists of interposing between the gear on the stud and that on the lead-screw, two other gears mounted on a stud carried by an adjustable spider, the combination of which may either reduce or increase the ratio existing between the numbers of teeth on the spindle and lead-screw gears. This is known as compound gearing, and consists of the substitution of two gears that run together on a sleeve, for the immediate idle gear. One of these two gears is driven by the gear on the stud, while the other drives the gear on the lead-screw.

The ratios given in the formula above no longer hold when compound gearing is used. Suppose that we placed on this intermediate stud two gears whose ratios were as 1 : 2, driving the large gear from the spindle and allowing the smaller gear to drive the lead-screw. We would then have multiplied the number of threads to be cut by 2, because the lead-screw will revolve just one-half as fast. Thus, if we use two gears with this particular ratio on the idler stud, we could multiply the number of threads on the lead-screw by 2 and proceed as in simple gearing; just so if the ratio was 1 : 3, multiply by 3 and proceed.

But another rule is often given. The spindle gear is a driving gear, as is also the smaller gear that drives the lead-screw gear; the larger gear of the pair revolving on the same sleeve (to which they are immovably fixed by a key) is a driven gear, and so is the gear on the lead-screw. Therefore, to cut a given number of threads when the lathe is compounded, select the three gears except the one for the lead-screw, at random. Place them in position and multiply together the number of teeth in the driving gears and the number of threads to be cut. Then multiply together the number of threads in the lead-screw and the number of teeth in the driven gear on the sleeve; divide the first product by this product and the quotient will be the number of teeth required in the lead-screw gear, which is the remaining driven gear. Where a ratio other than 1 : 1 exists between two revolutions of the spindle and the first stud, proceed exactly as in simple gearing, multiplying the threads of the lead-screw by the ratio, and using this figure in the calculations.

Signifying the two intermediate gears used in compounding in the following manner, the gear meshing with and being driven by the gear on the spindle of stud being known as Cd and the other gear mounted beside it on the sleeve and driving the lead-screw gear as Ca, we have the formula:

No. of threads to be cut × number of teeth in spindle gear × No. of teeth in Ca = No. teeth in Cd × threads per inch in lead screw gear, or $Lg = \frac{P \times Sg \times Ca}{Cd \times Lp}$

Using this formula, a table may be computed, show-

ing all the possible threads, fractional and whole, that may be cut with the set of change gears accompanying the lathe.

Owing to the fact that the metric system is used in several works in this country, this article would fall short of its purpose if the cutting of metric threads was not described. In the metric system, screw threads are usually expressed in threads per centimeter, and by proper compounding any lathe may be made to cut metric threads. A centimeter is equal to 50-127 or 50 divided by 127 equals .3937.

Let it be required to cut a screw having 8 threads per centimeter, look in the thread table for the simple gears to cut 8 threads per inch and put them in position. Then fill the intermediate space by two gears mounted immovably on a sleeve which may revove on a stud, having 50 and 127 teeth respectively, the gear with 127 teeth meshing with the gear on the spindle, while the gear with 500 teeth drives the lead-screw gear. The threads cut will be 8 per centimeter, and furthermore, the thread table accompanying the lathe may be used for cutting any other number of threads in the metric system, because the number of threads per inch and per centimeter remain the same throughout.

The usual forms of thread used in this country are the sharp V thread, the United States Standard thread or the Sellers system, the square thread and the acme thread. Each type has its particular advantage or disadvantage. The sharp V thread, owing to the bottom of the thread terminating in a very acute angle, weakens to a great extent the strength of the piece upon which it is cut. There seems to be a tendency for the sharp point of the tool to injure the metal beyond, perhaps starting an incipient crack which reduces the effective cross-sectional area of the piece. It is a difficult thread to cut owing to the fact that the fine point of the tool enters the metal first and at all times takes the heaviest load; being unsupported by the metal at the sides, a hard spot may crack off the point entirely. Then the sharp edge of the threads is very easily injured by coming in contact with other objects, and, after once being battered out of shape, it is almost impossible to get a close-fitting nut to go on. It is also very easily ruined if a small portion of the edge happens to become torn away and rolls up inside the nut.

The other threads will be taken up in the next chapter, together with the tools required to cut them; multiple pitch will also be spoken of in connection with screw cutting.

The underground railway system of London is operated only in part by electricity, steam locomotives still being employed on a number of the lines. When the electrification of all the subways is completed, as planned, one will be able to travel sixty miles underground without running twice over the same track.

WIRELESS TELEGRAPHY AT NIGHT.

Wireless telegraphy by night has a notable phenomenon attached to it. "Technics" points out that there is conclusive proof that wireless telegraph signals can be transmitted to a greater distance by night than by day, the ratio of the distances being as 5 is to two. At first sight this appears to be very extraordinary, but recent investigations afford a very simple explanation of it. In wireless telegraphy, electric "tubes of force" are projected into space from the sparking apparatus at the transmitting station: if they reach the receiving station they affect the coherer or other receiving apparatus. Now, it has been proved that a heated body emits negatively charging particles, or electrons, each possessing about one-thousandth part of the mass of a hydrogen atom. The sun, being at a high temperature, must emit these particles; some of these, when they reach the earth, strike against the gas molecules comprised in the atmosphere, and break these up into their constituent charged atoms. A single electron may dissociate a large nnmber of gas molecules. Hence in daylight the atmosphere contains numerous charged particles. If an electric field is established in the air during the daytime, the charged particles will travel along the "tubes of force". Now, the electric "tubes of force" projected from a wireless telegraph transmitting station, as they pass through the atmosphere, will set the charged particles in motion; since the charged particles possess inertia, energy must be absorbed when they are set in motion. and hence the "tubes of force" must lose energy and finally disappear. At night time the charged particles emitted by the sun are falling on the opposite side of the earth, since they travel in straight lines, like light rays; hence at night the atmosphere is practically free from charged particles, and is no longer rendered conducting. About two minutes after sunrise the atmosphere has become saturated with charged particles, and the absorption of the electric "tubes of force" has reached its maximum value. Since light consists of moving "tubes of force" similar to those utilized in wireless telegraphy, it might appear strange that light is not absorbed by the atmosphere; but in this case, owing to the very short length of the light waves, the field acting on a charged particle changes its direction about 4×10^{15} times a second; therefore the particle is not set in motion, just as no deflection is produced in a galvanometer by a quickly alternating current. In wireless telegraphy the wave lengths utilized average about 300 ft., or 9,000 ems, and the field at any point in the line of transmission, is reversed about 0.5×10^6 times per second.

The talent of success is nothing more than doing what you can do well, and doing well whatever you do, without a thought of fame.—Longfellow.

PHOTOGRAPHY.

CHANGING AND DEVELOPING BOX.

E. MASON.

The piece of apparatus described and illustrated below is one, the use of which by many photographers, means dispensing with the dark room altogether. A dark room, to most, is necessary only for the changing of slides and cameras with light sensitive plates or films, for negative and positive development, and a few supplementary operations rarely required. All these operations can be conducted with greater ease and comfort by the use of the changing and developing box.

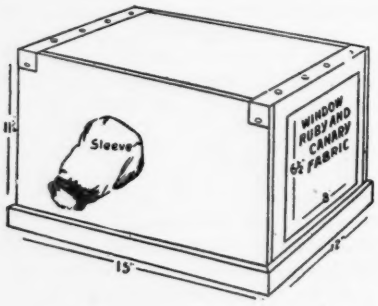


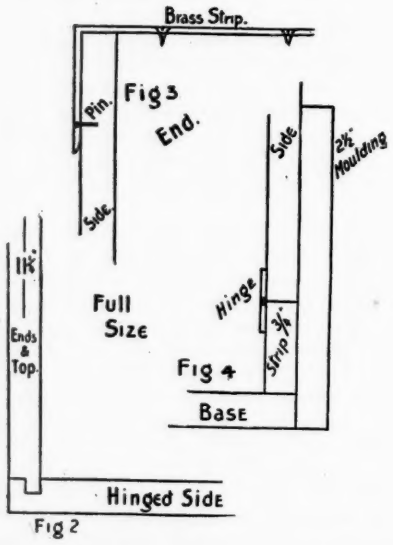
FIG. 1.

The dimensions of the box when folded are 15 x 12 x 2½ in.; erected for use its outside dimensions are 15 x 12 x 11½ in. The wood may be ¼ in. mahogany, walnut, or gum wood. The following pieces are required: Base, 14½ x 11½ in.; two sides, each 14½ x 11 in.; two ends, 11½ x 11 in.; top, 14 x 11½ in.; two mouldings, 15 x 2½ in.; two mouldings, 12 x 2½ in. There will also be wanted two brass strips, 13½ in x ½ in. wide, as shown in Fig. 1. One inch at each end of these there is turned at right angles and has a hole drilled a quarter of an inch from the end, which engages with a slightly projecting pin on one side of the case. The brass strips act in two ways—they preclude any possibility of light entering at the junction of the top and ends, and when the ends are pushed home lock all the parts together.

The sides have a ¼ in. groove across each end and top, and cut ¼ in. from the edge, the top and ends having an ¼ in. tongue to slide in, the same as shown in Fig. 2. One side piece is hinged directly to the base. A strip, 14½ x ½ in., is cut off the other side, and this is glued along the base inside and close to the moulding (see Fig 4). The object is to raise the side so that it will fold flat on top of the other side piece and sleeve.

The sleeve apartures are each 6 in. in diameter for sleeves 7 x 4 in. The sleeves are made of one thickness of "Ruby Christia," between two of black silesia. A rubber band is sewn in to grip round the arms. The flexible band to go across the eyes is made of moderately thick chamois (wash) leather. The window is made of one thickness each of ruby and canary fabric.

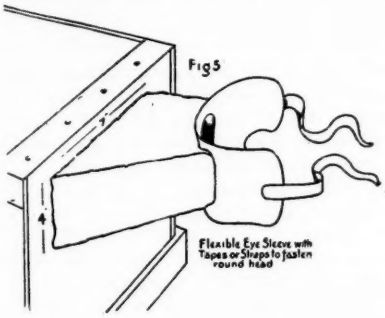
The outside of the case may be polished, but the inside must be finished dead black. In the size given I can develop whole plates.



Raising the sides, the top and window end are slipped in their respeective grooves. After pouring out the developer required, the measure containing it is placed inside against the window with any other solution that may be required alongside. Then follows a half-plate porcelain dish containing the fixing bath, covered with a light-tight lid; on the top of this stands the xylynite developing dish, also with a light-tight cover. After inserting the dark slide with the exposed plates, the remaining side is pushed home, making the whole case as solid as a block of wood. The eye sleeve is adjusted and the hands inserted so that the sleeves go up under the wearer's coat sleeves. As I use the time system I also place my watch in one corner of the case where it can be easily seen, and then if development is likely to be long, after placing on the cover, I withdraw my hands, remove the eye-shade, and simply rock the case slightly until development is complete. When finished the negative is placed in the fixing bath, covered with the lid, the end slipped up, and the

dishes, etc., washed. A duplicate fixing bath may then be inserted, and the whole procedure gone through with the next plate. Two fixing baths I find sufficient, using them alternately.

Development with such a piece of apparatus may be conducted anywhere, at any time. When not in use it occupies little space, and, being light, may be carried on tour, making the owner independent of doubtful "dark rooms." A great consideration is that the mouth and nostrils are outside, so that one does not



have to go on breathing contaminated air.

My recommendation, in conclusion, is to use an exposure-meter, to develop with a standard developer by the time system, to abolish the dark room, and with it one-half of the photographic worry will have forever disappeared. As a photographer, the sole trouble should be to discover a suitable subject, the correct lighting, and the most suitable view point. When found, the rest is easy, or should be if modern methods are adopted.

The case can, of course, be made larger or smaller to suit the size of plates generally used.—"The Photo-American."

DIFFICULTIES IN DEVELOPMENT.

Beginners often wrap exposed, but not developed, plates in printed paper, with the result that, in development, the letters appear on the negative, often to such an extent as to spoil the plate completely. It is impossible to remove these marks, but there is no reason why any such failure should occur, as plates, if packed face to face, with nothing whatever between them, and merely wrapped up in the brown paper as used by the manufacturers, will suffer no harm and will remain in perfect condition for a considerable time. To pass on now to the development, perhaps the commonest failure of the beginner is his inability to produce a negative clean and "fog"-less. Now, it is useless for him to blame the plates for this, as the plates of the present day are remarkably free from "fog," provided that they receive reasonably correct and careful treatment. The causes which may contribute to this "fog" are over-exposure to white light before or during development, an unsafe dark-room light, excess of alkali in the developer, and overheating of the dark room. The dark-room light should be tested by placing a plate, half of which is covered by an opaque card, at the spot usually occupied by the developing-dish for ten minutes or so; if, on development, any difference can be seen between the two halves of the plate the light is not safe, and must be screened by an extra thickness of non-actinic medium. Again, alkali is often added in large quantities to the developer for the purpose of forcing out detail on an under-exposed plate, and this is a frequent cause of fog. The developers recommended in the makers' instructions are usually rather too concentrated and include rather too much alkali than is advisable for general use by a beginner; most of these formulæ would be improved by the use of twice as much water and half as much alkali as is advised in the directions. When caustic soda is the accelerator employed, the addition of water and reduction of accelerator is particularly necessary, in order to avoid a harsh negative or a ruinous amount of fog. Overheating of the dark room is most likely to occur when development is carried out in a badly ventilated room, with an ill-kept oil lamp or a powerful gas jet. With regard to density, it is an open question whether more negatives are spoiled by being thin and ghostly or by being harsh and over-contrasty. The chief causes of thin negatives are over-exposure, under-development, too weak a developer, or slight excess of alkali, while harsh negatives are generally the result of the exact opposite of these faults. Our aim must be, when we have found out in which direction we are erring, to strike the happy medium, and to do this we shall do well to use the same brand of plate and the same developer time after time, blaming ourselves, and not our materials, for our want of success, and striving to master the peculiarities of one plate and one developer before turning to others which are probably no better and about which we know absolutely nothing.

The system of time-development introduced by Mr. Watkins has much to recommend it, and its adoption by beginners would lead to regularity and absence of that uncertainty which is, unfortunately, so characteristic of their work. Another common fault is the disfigurement of negatives by markings or patches, generally caused by uneven flowing of the developer over the plate, sometimes by the use of an insufficient quantity of developer to cover it fully. The best way to pour on the developer is to hold the dish, with the plate in it, in the left hand, and the measure of developer in the right, and then to pour the liquid gently but quickly along one edge of the dish, starting from the farthest right-hand corner, tilting the dish so that the developer flows over the plate in one sweep.

Air-bells, too, are very annoying, since, where they form, the plate is not acted on by the developer, and, when fixed, shows transparent holes, which print out out as black spots; they can be avoided by passing a

broad camel-hair brush lightly across the plate as soon as the developer is turned on. Wetting the plate before pouring on the developer is almost certain to give rise to air-bells. These are but a few of the errors which can be made by the inexperienced; but if these points are attended to much waste of plates, time and trouble will be avoided.

"The Photo American."

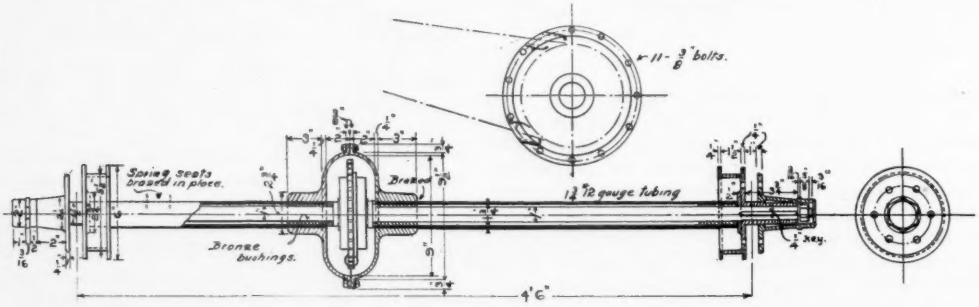
THE AMATEUR RUNABOUT.

FREDERICK A. DRAPER.

IV. The Rear Axle.

The rear axle of an auto requires quite as careful work as any other part. It is not only subjected to bending strains due to vertical load, but it must also resist the pull of the chain. Then, when the hub-brake is used a severe torsional strain is imposed and the combination of the three subjects this part to the most severe twisting and bending strains.

The spring-seats are brazed to the tubing before assembling, and their position can best be determined after the exact spring position is determined. The spring seats should have lugs to receive the ends of the radius rods, or these may be attached to separate castings brazed on to the tubing.



The cut shows a sectional elevation of the axle with the hubs and muff enclosing the differential. The outside shell is made of 1¾ in No. 12 gauge seamless drawn steel tubing. The lengths are cut to suit the work, depending on the width of tread, and are brazed into the separate halves of the muff. Two bronze bushings are forced into the ends of each half and secured by a pin. These bushings can be made of brass tubing, which can be obtained in any large city.

The sides of the muff are turned on an arbor and finished with a male and female joint. This insures a perfect alignment of the bearings. The tubing is brazed into its sockets, which makes a very strong job. The muff is provided with two openings through which the chain passes. The flanges are provided with holes for 11 ⅜ in. bolts.

The shafts are of 1 in. cold rolled steel shafting fitted to the hubs and provided with a key. A nut on the ends of the shaft keeps the hub in place.

Each inside hub-flange is provided with a drum for the brake band. These are turned true and smooth. Where the shafts pass into the differential case they are provided with collars pinned in place, each half of the shaft is keyed to one of the differential gears, as will be described and detailed in the next chapter.

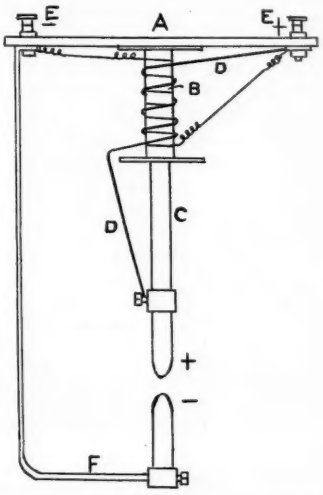
Speaking at the Royal Institute, London, recently, on "Fungi," Prof. Ward said that the mould on wall paper was rather on the paste than on the paper. With cheese, it was the water in it that gave rise to mouldiness, while that on boots was an outcome of the blacking, not of the leather. Ninety to ninety-five per cent of the fungi was water, and this was so in the case of mushrooms. There was a popular mistaken notion that these fungi were nutritious, but there was very little nutriment even in a hundredweight. The other 5 per cent. or 10 per cent. was made up of nitrogen and oxygen. Jellies, in particular, were the choice food of moulds. Some fungi were so luminous that photographs had been taken of them by their own light. These fungi were very destructive. They simply ate up whatever they fastened on, mostly wood. There was also a mould which the professor called "lurking fungi". This generally attacked grain, and in a way went to sleep between the seed and its husk. They were poisonous and had caused epidemics in the past. It was his belief that beri-beri was caused solely by a "lurking fungi" in the rice. This was a very serious thing to Eastern nations, especially to an army in the field, like that of the Japanese.

PRINCIPLES OF ARC LAMP CONSTRUCTION.

Electricity may be defined as matter in motion along definite lines through material capable of having its particles moved by this force. When the particles yield readily to the force brought to bear upon them, their temperature is very slightly altered; but when they resist electric force, their temperature rises rapidly. When many lines of force are brought to bear on a small number of particles, the great strain on them causes their temperature to rise considerably and, in some cases, entirely overcomes their bonds of cohesion. This is the case when a large number of lines are forced through a thin carbon rod. The particles of carbon resist electric force and get warm, then hot, then red-hot, then white-hot, then incandescent, and finally break away under the great strain. When two such rods are placed end to end to form a conductor of electric current, their particles at the ends are imperfectly connected, and their consequent resistance is higher; they therefore soon become white-hot and break away from the solid mass, but at the same time they heat the air around them, and this hot air also conducts the current Small particles of carbon, glowing at a white heat, are carried by this current of heated air from one carbon rod to the other, and others are turned into incandescent vapor in the space between them, to form an arched bridge of light known as the electric arc light.

To produce this arc the electric current must have volume sufficient to make the carbon particles white-hot, and sufficient electro-motive force to carry them over the space between the tips of two carbon rods. The volume of current required to incandesce carbon rods at their tips in an arc lamp may be put down as 5 amperes for each ¼ in. in diameter, while the E. M. F. is a constant of from 45 to 50 volts for all ordinary arcs these being formed when the carbon rods are 1-12 in. apart. The light given by an electric arc lamp may be put down as 500 candle power for a 5-ampere lamp. If, therefore, two carbon rods, each ¼ in. in diameter, are so placed together that their two ends firmly touch each other, and an electric current of 5 amperes and 50 volts is made to pass through the carbons, the point of contact will first get red-hot, then white-hot, then glow with much brilliance, while the carbon particles burn away, until the gap between the ends of the carbon becomes 1-12 in. wide. A bridge of burning carbon in the form of an arc will then emit a brilliant light for a few moments, while the arc lengthens to ½ in. and then expires, unless the carbon rods are moved towards each other and the arc gap maintained.

An arc lamp, therefore, is a small machine made to hold the carbons and move them towards each other as they burn away, so as to maintain the right space between them to form the arc. But it must do more than this. It must be so constructed as to separate the carbon rods when they are hot enough to give the necessary light, and thus "strike the arc". Numerous devices have been invented to attain this end, and some wonderful pieces of clockwork mechanism, combined with electro-magnetic apparatus, have been sold as arc lamps. One of the most simple forms, embracing the leading principles of construction in the lamps, is shown in the accompanying illustration, where, fixed



by its upper part to a platform *a* of wood or of sheet-ebonite, is a hollow brass bobbin, *b*. A soft iron rod, *c*, nearly fills the hollow space in this bobbin, and is made to slide in it freely. The lower part of the rod is enlarged to form a socket to hold the upper carbon rod, also a small milled terminal screw for attachment to the flexible conductor shown in the sketch. The bobbin is wound with two coils of wire. A thick wire coil, *d* capable of carrying the full current consumed in the lamp is connected in series with the carbon-holder (this coil makes only a few turns round the bobbin), and a thin wire coil of several ohms resistance is wound over this, as shown by the thin line. This coil is connected in shunt with the main circuit to the two terminals, *e*, on the platform. The lower carbon is held in a suitable socket attached to the bracket, *f*, the upper part of which is connected to one of the terminals above.

When this lamp is unconnected with an electric current, the two carbons rest upon each other and are kept in close contact by the weight of the iron rod. But when a sufficiently strong electric current is connected to the two terminals, *e*, it traverses the thick coil, *d*, and converts the air space within the bobbin, *b*, into an electro-magnet, called a solenoid (which has the

property of sucking the iron core, *c*, into itself); the carbon-holder is therefore drawn up, the carbons are separated, and the arc is struck.

If the current is too strong, the upward pull of the solenoid will jerk the carbons violently apart, and, as this will break the circuit, they will as suddenly fall together again, with a resulting pumping action and unsteady, flashing light. To counteract this fault, the bobbin is also wound with many turns of a long, thin wire in the opposite direction, and this wire is connected in shunt across the terminals. A part of the current therefore traverses the fine coil, and induces a contrary magnetism in the solenoid, which serves as a brake on the otherwise violent upward pull of the main current. When the turns of the wire in the main coil are properly proportioned to the turns of wire in the fine coil, the two coils so balance each other as to maintain the gap between the ends of the carbons at its proper length to produce a steady arc light. In an arc lamp of this design, the magnetic solenoid acts against gravity to pull the top carbon up from contact with the bottom one. As it does this the arc is first formed, then lengthened, and with the lengthening a higher resistance to the current is created, with the result that less current passes through the main coil and the magnetism of the solenoid is weakened. The carbon therefore drops a little, and the arc is shortened; but as the resistance of the main circuit increases, more current goes through the fine coil and checks the downward course, as it checked the upward course, and thus the balance is restored when the normal arc is formed.

In a good lamp, well designed and adjusted and kept clean, these intervals of up and down movement are so short as to make the feeding of the carbons appear continuous. The proportionate resistance of the two coils is usually 1 to 100; that is, the series coil as 1 ohm, and the shunt coil 100 ohms. The gauge of copper wire employed in the series must be large enough to safely carry the current required to maintain the arc light. The flexible wire cord connecting this coil to the upper carbon must have the same capacity. If the current to be carried by the series coil is 5 amperes, the wire in this coil should be No. 14 s. w. g. copper, cotton-covered and parafined; and the flexible wire cord should be 100-36 silk braided.

The illustration given is only intended to show the principles of construction in one of the most simple designs of arc lamps. An arc lamp embodying these principles can be constructed and designed by almost anyone following the hints here given. First decide upon the candle-power of the lamp, and choose a suitable pair of carbon rods. The sizes given by makers run from 8 mm. to 30 mm. and vary in price from 1½c to 12c per foot-length. The smaller diameters are for lamps of low candle-power, taking a small current. The rods are made solid for the lower carbon, and cored for the upper carbon. On referring to the illustration, it will be seen that the lower carbon rod is pointed and is marked —, indicating that is the negative carbon and most be connected to the negative pole. It is a solid rod, and as it does not burn away so fast as the upper carbon, it may be made shorter. The upper carbon has a slightly hollowed end and is marked + to show that it is the positive and so must be connected to the positive pole. The current will therefore pass from the upper carbon to the lower, and frit off more particles from the upper rod than it does from the lower one. As it burns with a hollow center—called a crater—it is made with a soft core. These facts must be noted when buying the carbon rods, the length of which must be determined by the number of hours they are required to burn, the approximate consumption being from 1½ to 3 in. per hour for the two rods; the proportion for each rod being 2 to 1, that is, 2 in 3 for the positive, and 1 in 3 for the negative carbon.

When the size and length of the carbon rods have been determined, all the dimensions of the other parts of the lamp can be adapted to them. The diameter of the carbon holders must be adapted to that of the carbon rods. The length of the upper carbon holder with its iron core must also be adapted to the carbon, and the bobbin to the solenoid coil to the iron core working in it. After this, the dimensions of the frame and platform can easily be determined. If it is desired to enclose the upper part of the lamp in a brass case, this can be added, together with any other conveniences, after the lamp is made. Connection is secured between the lamp and the source of current by means of flexible wire cables.

The foregoing principles of construction have a modified application in some of the best lamps. In the Brockie-Pell lamp, two solenoids, side by side, regulate the arc by means of a lever and brake action. In the Brush lamp there are two sets of carbons, worked with two solenoids side by side, and regulated by a triangular clutch between them. In the Angold lamps, two solenoids actuate a lever and ratchet device, and a brake to regulate one set of carbons.

To avoid the shortening of machine belts, one firm cuts them too short, when they are first applied to the machine, by a length of 1 ft. or several inches. When the belt grows slack this piece is removed, and a shorter piece is inserted instead. A variety of widths and lengths is kept for this purpose, and when a machine operator wishes to shorten a belt, he determines about how much slack needs taking up, and gets a piece that much shorter than the one already in the belt. The piece is returned to be used again as occasion requires. This system prevents the actual belt from being wasted and obviates the necessity of squaring ends and punching new holes each time the belt is shortened.

Oil for cylinder lubrication cannot be too good. A new cylinder costs more than a great deal of good oil.

RELAYS FOR WIRELESS TELEGRAPHY.

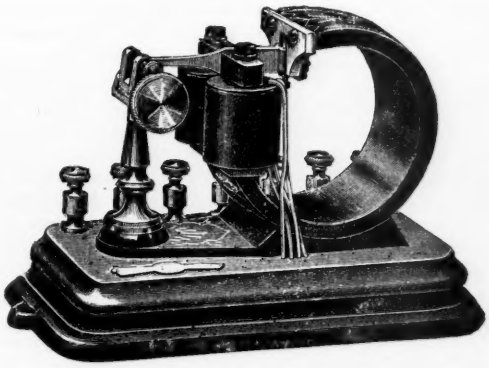
ARTHUR H. BELL.

Amateurs interested in Wireless Telegraphy are often puzzled as to the best relay to use in connection with their receiving apparatus, and as a sensitive relay is very essential, I will briefly describe the different kinds of relays that are on the market or which may be constructed at home, and give the reasons why one type is superior to another.

Nearly every amateur is familiar with the telegraph relay, so common to wireless telegraphy. This type of relay is a neutral or simple electro-magnetic relay, designed with magnets exactly like the magnets of a vibrating door bell, only finer wire is used in the coils. In this type of relay it matters not as to the direction of the current in its course to the relay, the only requisite being that there be enough "juice" passing into the relay to magnetize the cores and attract the armature, and in the ordinary 150 ohm telegraph relay, by careful adjustments, one can make the armature throw over with the current from one cell of dry battery. But anything less than 1½ volts will not do this every time. So, for service in a coherer circuit where, under normal conditions there is not sufficient current passing into the relay to cause it to operate, and where the current increases considerably when the coherer is affected by the Hertzian waves, the telegraph relay is a good instrument for short distances only, say for one to four miles at the most.

There is a relay, however, used universally in telegraphy which one does not find in every small office, but which plays a very important part in rapid commercial business where one telegraph circuit is handling two or more messages simultaneously.

This apparatus is the polarized relay, unquestionably the most sensitive instrument to be obtained at a moderate price. By examining the illustration the reader will note that there is a permanent magnet of horse-shoe type, having at one pole a pair of wound electro-magnets exactly like the magnets on the ordinary relay. As these magnets have soft iron cores, it should be understood that the magnetism of the steel permanent magnet saturates them and makes both of them of the same polarity as the tip of the steel magnet to which they are fastened; that is to say, if the bottom pole of the permanent magnet is south these poles of the electro-magnet are south. To the other pole of the permanent magnet is pivoted, sensitively, a soft iron bar which takes, of course, the same polarity as the pole to which it is affixed. So we have a movable north pole playing between the two poles of the electro-magnets, and bear in mind this point, this condition of affairs occurs only when the current of electricity passing through the coils from the battery, is not of right direction of flow to change the polarity of the coils and cause the armature to swing over because of this change. So we note that the operation of a polarized relay does not depend on attraction; that is, sufficient generation of lines of force to pull a soft iron armature towards the poles of an electro magnet, as with the first type of relay, but depends absoutely on changes in direction of current.



In wireless work there is sufficient tension put on the pivoted armature to cause it to hug the pole opposite the contact point, and the battery is poled right by testing, so that when applied directly to the windings, the armature swings over instantaneously and makes contact. With this relay and a dry cell in circuit with the filings coherer and a small set of adjustable resistance cut into the circuit, by close adjustment the permanent magnetic effect of the relay can be opposed with just enough poled energy, when the coherer operates, to make a very delicate and rapid contact.

Any amateur who wishes to experiment with a polarized relay will find the 600 ohm bell used by telephone companies a very satisfactory instrument and very easily constructed for wireless work.

The "gold from sea water" craze appears to be having a lively run in England at the present time, and it is asserted that no less a person that Sir William Ramsey has endorsed a process for extracting the gold. Unless such approval appears over the signature of this eminent scientist, the statement should be viewed with suspicion. Many investors in a similar enterprise in this country would have little faith in it, if all the scientists in the world gave approval.

PHOTOGRAPHIC NOTES.

A good photograph of a lightning flash is reproduced in a recent issue of "Photography". The photograph was taken in July last at Weston-super Marc by T. G. Goodman, A. C. P., F. R. G. S., who states that it was taken on an Ilford chromatic plate, and has not been touched up in any way. The camera was focussed in a perfectly dark room on a light in a room some distance off. The plate was then inserted, the cap removed, and within a few seconds a brilliant flash came in that part of the sky to which the camera pointed, immediately after the cap was put on. The stop used was ⅛; date, July 21, 1904; time, eight minutes to ten. "Photography" says that it is not often a single flash single, that is, in point of time—makes so fine a show as it does in Mr. Goodman's print, which is altogether remarkable in this respect. Those who would seek to get similar results would do well to note his procedure. It is a convenience to have a mark on the baseboard of every camera, showing exactly how far to extend the camera with any given lens to secure a sharp image of anything at "infinity". This is most conveniently done in day time by focussing on some object two or three hundred yards away, since, when a storm does come there is not always a light at a suitable distance on which to focus. Then when a thunderstorm happens at night, all that has to be done is to extend the camera to the mark, put a plate in, point the camera in the direction in which most flashes are to be seen, and uncap the lens. As soon as a flash has been seen, in that direction, the plate should be changed, and as it often happens the flashes that are very visible to the eye do not appear on the plate at all for one reason or another, it is always advisable to make as many exposures as the storm will admit; some are then sure to be found on the plate.

A French photographer, M. G. A. Liebert, has recently devised an apporatus which will enable him to take instantaneous photographs in his studio. This device is described in *La Revue de l'Electricite*. The object of using electric lights is to give the photographer entire control of the quality and amount of illumination and to render him independent of daylight. Moreover, to obtain the best portraits it is very desirable that they should be taken instantaneously and at the moment when the subject is in the best pose.

The device consists of a large parabolic reflector of aluminum, having placed on its inner edge a series of incandescent lamps shaded with ground-glass screens. The object of these is merely to light up the subject, permitting the photographer to secure the best pose and to determine when the real exposure should be made. At the center of this reflector is an arc lamp with three carbons. One of these is fixed, and the other two are movable. When a photograph is to be taken, the subject is arranged and the sensitive plate is exposed. The photographer then waits until a desirable pose has been secured, when he presses a rubber bulb, which draws the two movable arc light carbons across the fixed one, thus forming a brilliant arc; but the moment the current passes through the lamp the movable carbons are drawn away from the fixed ones by means of an electromagnet, and the arc is thus extinguished. It lasts about one-fiftieth of a second, but this gives sufficient time for an exposure.

ONE SESSION FOR SCHOOLS.

Dr. Otto Dornblueth, of Frankfort, a specialist in nervous diseases, writes against the practice of holding afternoon sessions in the public schools. In support of his position he points to the investigations instituted among 16,000 school children by the distinguished expert in school hygiene, Dr. Schmidt-Monnard of Halle, who found that the number of sick among the children attending morning and afternoon sessions was by one-half greater than among children who attended sessions in the forenoon only. The investigations by Prof. Koppman of Leipzig, led to the same conclusion.

Dr. Dornblueth favors a morning session of five hours, giving a resting pause of fifteen minutes at the end of each hour. He says that the afternoon sessions exhaust the vitality of the children, disturb their digestive organs, and tire their brains. From a medical standpoint afternoon sessions should be abolished. The afternoon hours should be given to play, outdoor exercise and physical training. The selfish motives of many parents in not wishing the children at home because they are bothersome and require supervision should not avail against a reform which is necessary and beneficial for the little ones. The doctor suggests the establishment of public retreats where the children who cannot be supervised at home may spend the afternoon hours in the care of one or more suitable adults. He suggests that these retreats be provided with implements and material and that children desiring instruction in light handicrafts may be accommodated. This may give the initiative for training clever women and good mechanics.

Under the present system of instruction the pupils of the upper school classes attend forty-two and some forty-four hours per week.

A method of distingushing iron from steel is to wash the piece of metal to be tested and then plunge it into a solution of bichromate of potash, with the addition of a considerable quantity of sulphuric acid. In from thirty to sixty seconds the metal can be taken out, washed and wiped. Soft steels and cast-iron will have assumed a regular ash-gray tint; tempered steels will have become almost black, without any metallic reflection; puddled and refined irons will remain nearly white with metallic reflections on the part of their surface previously filed, the remainder of the surface presenting irregular blackish spots.

BOOKS RECEIVED.

AMERICAN TELEPHONE PRACTICE. Kempston B. Miller. Fourth edition. Enlarged and Entirely Rewritten. 904 pp., 6½ x 10 in. 643 Illustrations. Cloth. Price. $4.00. McGraw Pub. Co. New York. Supplied by AMATEUR WORK.

It is not an easy task to give, in the space available, a comprehensive idea of this magnificent volume. The preceding editions have made it well known as an authority to all telephone engineers, and the completeness with which the new edition brings it up to date, will undoubtedly make it the leading book upon the subject for a long time to come. A copy should be in the hands of everyone engaged in telephone engineering work. As the publishers have issued an illustrated prospectus containing table of contents, etc., which will be mailed to any one sending for it, we would recommend those interested in this subject to secure same, or better yet, order a copy at once, as it will repay the cost to the owner.

GAS ENGINE DESIGN. Chas. Edward Lucke, Ph. D. 254 pp. 6 x 9 in. 154 illustrations. Cloth. Price $3.00. D. Van Nostrand Co., New York City. Supplied by AMATEUR WORK.

The purpose of this book is to present in compact form those principles which underlie the design of gas engines, together with such data on the subject as seems reliable for the use of those engaged in building this kind of machinery, and who are familiar with its characteristics. The book is concerned entirely with the quantative side of design, and treats solely of the forces in, and the energy-transforming power of the exploding gas-engine.

The work is divided into three parts. The first, treating of the power, efficiency and economy, gives the material necessary for deciding on the necessary piston displacement for any kind of gas, and enables the designer to approximately predict economy. The second part contains the data and method for determining the stresses in the parts and the number and arrangement of cylinder necessary for balance or turning effort to meet the specifications. The last part is entirely concerned with the dimensions of the parts to meet the stresses, showing between what limits every principal dimension should lie. It is a book of great value to those engaged in designing and building gas-engines.

ELECTRICAL INSTRUMENTS AND TESTING. N. H. Schneider. 200 pp., 5 x 7¼ in. 104 Illustrations. Cloth. Price $1.00. Spon & Chamberlain, New York. Supplied by AMATEUR WORK.

This book is intended for practical use, and also as an introduction to the larger works on the subject. The apparatus described is of the most modern type, such as will be found in universal use. The tests are such as occur daily in the work of the engine room, power house or technical school. Beginners in the study of electricity will find it of great value.

ELEMENTS OF MECHANICS. Mansfield Merriman. 172 pp., 4¾ x 7½ in. Cloth. Price $1.00. John Wiley & Son, New York City. Supplied by AMATEUR WORK.

This book is intended for manual training schools, freshman classes in engineering colleges, or for students who have the preparation above indicated. It is an attempt to apply the best methods of applied mechanics to the fundamental principles and methods of rational mechanics. To this end constant appeals are made to experience, through numerous numerical illustrations, many queries and problems are stated as exercises for the student, and a system of units is employed with which every boy is acquainted. It should prove an excellent text-book in the special fields for which it is intended.

PRACTICAL WOOD CARVING. Charles J. Woodsend. 86 pp. 6 x 9 in. 108 Illustrations. Cloth. Price $1.00. David Williams Co., New York City. Supplied by AMATEUR WORK.

This book has been written for the special purpose of meeting the requirements of the young mechanic or student who is desirous of acquainting himself with the rudiments of the art, and an examination shows it to be especially adapted to fulfilling its purpose. The reader who will follow the directions given and repeatedly practice the examples, cannot fail to possess a good knowledge of the principles of wood carving.

PRACTICAL METHODS OF DEVELOPMENT, No. 66; PRACTICAL ORTHOCHROMATIC PHOTOGRAPHY, No. 67; PHOTO-MINIATURE. 48 pp. Paper, 25 cents each. Tennant & Ward, New York.

No one who is doing regular work in photography now tries to get along without each and every one of this valuable series of photographic studies. They are all well worth the having.

Some interesting notes on diamonds, recently published, contain reference to the fact that apophyllite, a silicate of lime and potash with 16 per cent of water and easily fusible at the ordinary temperatures obtained with a blowpipe, has been found inside a diamond. This is considered to disfavor the idea that diamonds had an igneous origin. A leaf of gold has also been reported in the center of a crystalized Brazilian stone. These facts are considered incompatible with the formation of stones at high temperatures, and additional argument is derived from the great size of the stones, which seems to favor the idea of a slow gowth analagous to that of ordinary crystals.

"Let a man do a thing incomparably well and the world will make a beaten path to his door."—*Emerson.*

CORRESPONDENCE.

No. 89. PORT ORCHARD, WASH., May 3, 1905.

Having been a subscriber for and purchaser of of every copy of AMATEUR WORK which has been issued, I presume to seek the following advice: Between my office and home the distance is four miles, unobstructed salt water. Is it possible for me, an amateur, to operate a wireless telegraph between the two points with any degree of success? If so, what would be the probable cost of the necessary equipment, and would it be better to attempt to make, or buy the apparatus? If to buy, where can I purchase the most successful instruments, within the reach of the pocketbook of one who does not desire to spend any more money than is absolutely necessary to have a satisfactory working system, and not one that is more trouble than it is worth—if any such exist—which I wish you would tell me honestly. J. G. B.

Replying to your letter of May 3. The location of your home and office, as you describe it, offers an exceptional opportunity for wireless communication. Success in wireless telegraphy depends as much on the amateur's understanding of the principles as upon the selection of instruments, for the best of apparatus on the market has its shortcomings, which can only be remedied by careful harmonizing of working conditions.

You will need a pole at each end, either a few feet high from the house top, or rising 40 to 50 feet from the ground. Each station will require a spark coil giving about 4-in. spark, and operated by 10 or more cells of dry battery. A smaller spark might suffice, but it is advisable to have reserve power over the requisite amount. Coils, in fact the entire sending end, may be constructed at home, if the maker has the time and materials.

It is difficult to express an opinion by letter as to the advisability of constructing all the "receiving" instruments at home. Amateurs have accomplished this at very moderate expense, but there are rules which can not be laid down specifically, each man's experience differing from that of every one else.

A coherer is difficult to make. A good one can be bought for $4. You can construct a sensitive relay for about $5 and a sounder for $1, or you can buy the coherer, decoherer, relay and sounder in the form of a set, of apparatus concerns, for from $25 to $35, according to accuracy and finish.

If we were in your place, we would commence a set of experiments, constructing the spark coil, pole wiring and other appurtenances of one sending end, as carefully as possible. Then purchase a coherer, and a 25-ohm relay of the regular telegraph type, and make experiments in the arrangement of apparatus until every depression of the sending key operates the receiving end. Having accomplished this construct a decoherer, descriptions of which have appeared in AMATEUR WORK, and connect it in the relay circuit. Then experiment until the receiver receives each impulse and decoheres as it should. You may now purchase the sounder and complete the first receiving set. By experimenting as you build, you will be likely to save considerable money on the second set, which will be a duplicate of the first.

We have gone into all these details, not to discourage, but rather to interest you in what will prove most entertaining and instructive work. Even if you bought the most elaborate sets on the market at a cost of hundreds of dollars, there would be times when you would have to exercise all your ingenuity to make everything work. We have subscribers who have done as we advise you, and their results have been highly satisfactory, over much longer distances than required by you.

No. 90. ROCHESTER, N. Y., May 9, 1905.

Will you kindly answer the following questions through your valuable magazine? (1). How can a watch be demagnetized? (2). What rated spark would be necessary for wireless telegraph stations at a distance of three miles? What would be the cost of the material providing I have purchased the coil?

L. W. O.

(1). To properly demagnetize a watch, especially one of any value, is a rather delicate operation requiring considerable experience and a suitable outfit, and we would not recommend any one unacquainted with the work attempting to do it.

(2). A wireless telegraph outfit to operate over a distance of three miles on land would undoubtedly require a coil giving a 4 in. spark, but much depends upon the construction of the receiving end and local conditions. The cost would all depend upon how much of the apparatus was made by the owners, the coherers should be purchased, although it is recommended that some of the types described in the magazine be made for the purpose of becoming familiar with their operation.

No. 91. TOLEDO, OHIO, May 26, 1605.

Will a rheostat of the type described in AMATEUR WORK, January, 1903, work well on a lighting circuit of 110 volts, 19 amperes? I have not had success with it, as it did not cut the current down to the desired extent; in fact, not to any noticeable extent. Is carbon resistance suitable for controlling the motor or continuous work of any kind? Will it last as well as German silver wire? G. H. D.

The rheostat mentioned is not suitable, either in size or type, for the work mentioned. It is of much too small a capacity for the current, and it is fortunate that no harmful effects resulted from its use. It would have little appreciable effect in regulating a current of the volume named. We hope to publish, at an early date, a description of a rheostat suitable for regular lighting circuits. If only a small current is needed a lamp could be used to take most of the current, the balance being used as required.

No. 92. EAST AURORA, N. Y., May 9, 1905.

Can you tell me how to make a Tesla oscillator; also a small telescope? E. L. F.

A description of a Tesla oscillator of a size suitable to work with a Rhumkorff coil giving a 4-in. spark, is in preparation. The first chapter of a description of a reflector telescope appears in this issue. This instrument, while not large or difficult for the amateur of fair skill, is of a size which will permit of very interesting and valuable astronomical work.

No. 93. NEW HAVEN, CONN., May 4, 1905.

I have a lathe built on the plan given in the AMATEUR WORK for July, August and September, 1903. The way I have of driving it at present is not satisfactory, so I would like particulars of a motor strong enough to drive it. Where can I get a motor or the castings for one? What fraction of a horse power is necessary? What voltage would be required? What type of battery would be best? H. S. P.

The power required to drive a turning lathe, even of such a small size as the one you have, is greater than might be thought until actual experience has shown this to be so. A quarter horse power motor would be necessary to give the power and speed on heavy work, and sufficient power should always be provided to take care of the heaviest work a machine is given. For light work or light cuts on heavy work, less power might answer, say one-eighth horse power, but to run an electric motor of even the smaller power by battery current, would call for an expensive battery outfit as well as heavy expense of maintenance. A storage battery would not be expensive to maintain, if one had the charging facilities.

The most suitable driving device for the lathe is a drive wheel operated by treadle. A stand can be made of wood, the drive wheel keyed to a shaft, on each end of which are lugs and bolts to connect with treadle rods to the treadle. This gives ample power, is inexpensive to fit up and costs nothing to run.

No. 95. JACKSONVILLE, ILL., May 14, 1905.

Will you kindly answer the following questions relative to wireless telegraph apparatus described in the November and December, 1904, numbers:

1. What should be the resistance of the variable inductance coil described in the November number?

2. What capacity should the Leyden jars be for the battery described in the same number and how many jars should be used?

3. Using a coil giving a one-inch spark, how far is it possible to transmit and receive signals, with the apparatus described in the November and December numbers? C. B. V.

The resistance of the variable inductance should be as low as possible, using as heavy as No. 12 gauge copper wire, or even larger. The capacity of the Leyden jars should be .0005 M. F. each for coils up to 2 in. spark. With a 50-ft. aerial wire at each end and very sensitive coherers, relays, etc., it is possible to send, with a coil giving a 1-in. spark, for a distance of one mile over land, or even further, but local conditions have considerable bearing on the results attained, no fixed rule being possible.

SCIENCE AND INDUSTRY.

The size of the Atlantic waves has been carefully measured for the Washington Hydrographic Bureau. In height the waves usually average about 30 ft., but in rough weather they attain from 40 to 48 ft. In storms they are often 500 to 600 ft. long, and last 10 or 11 seconds, while the longest yet known measured half a mile, and did not spend itself for 23 seconds.

An interesting correspondence, says the London "Electrical Review," has been proceeding for some time in the "Chemiker Zeitung" on the cause of the occasional explosions of vapors which have taken place at different chemical works. A very inflammable volatile liquid, carbon bisulphide, more particularly, has been run through metallic pipes, or through a metallic funnel, into a metallic or non-metallic drum, replacing the air formerly in that vessel. Part of the liquid has evaporated, forming a mixture of vapor and air, which, in the total absence of fire or artificial light, has exploded and done more or less damage. It has been so difficult to find the proper explanation for this curious phenomenon, that certain writers have suggested that the friction of the passing liquid upon the edges of the funnel or the mouth of the pipe must have generated sufficient electricity to produce a spark, which has immediately fired the explosive mixture.

A more probable and entirely chemical explanation of the explosions has now been put forward, which appears to meet all the requirements of the case. According to this view, when a volatile organic liquid of the kind now under consideration, which contains sulphur either as a part of its nature, or as an impurity, is brought into contact with iron or steel, sulphide of iron is formed. In presence of air this body oxidizes, generating so much heat in the process as to raise the mixture of vapor and air above its inflaming point, when, if it takes fire in a confined situation, it produces the symptoms of a gas explosion.

Stone sawing by wire is done successfully in France, according to a paper by Mr. E. Bourdon in the "Bulletin" of the Society for Encouragement of National Industry. A complete plant comprises an endless wire passing around a series of pulleys, one of which is a driving-pulley. The necessary tension is obtained by a straining trolley working on an inclined plane, and between the driving shaft and this trolley is situated the saw frame, which carries the guide pulleys for the wire saw. This wire, which is driven at a given speed, is caused to press lightly on the stone, and the cutting is done by sand mixed with water, which is conveyed into the saw cut as the work proceeds. Though the

mode of operation appears simple, it entails various difficulties in practical application. Three twisted steel wires are used, each wire having a diameter of 0.098 in. The strands must be twisted fairly tight. and should make one turn in 1.18 in. The wire may be driven in the workshop at a speed of 23 ft. per second, but in quarries, drifts and mine tunnels the speed should not exceed 13 ft. per second. The force exerted by the wire to produce the cut must be uniform and must be capable of being readily varied. Moreover, it must be proportionate to the length of the cut.

Carbon and metal brushes for dynamos have their advantages summed up in "Technics," according to which a most important departure in dynamo design was made when carbon brushes were introduced. With metal brushes sparking can only be avoided by altering their lead, with every variation of load. When carbon brushes are used, and the dynamo has been suitably designed, absolutely sparkless running may be secured for all loads with fixed brushes. It is, perhaps, not too much to say that the present success in the design and construction of large traction generators is due to the use of carbon brushes. Their superiority to metal brushes is due to several causes. In the first place, metal brushes, when greatly heated, are liable to fuse at the tips, with the result that the commutator becomes pitted. In addition, metallic vapor is sometimes produced, and this gives rise to an arc between the brush and tip and the commutator segment which has just left it. Both these sources of trouble are removed when carbon brushes are used. In addition, there is a definite contact resistance between a carbon brush and the commutator segment on which it rests, and this resistance increases as the commutator segment is withdrawn from under the brush. The effect of this is that the current in the armature coil, short-circuited by the brush, is first reduced to zero, and then reversed, without any help from a reversing field. The method of commutation with movable brushes may be compared with the method of stopping a locomotive by reversing the engine, while the use of fixed carbon brushes for commutation may be compared with the use of a brake.

The waste of gold in a manufacturing jeweller's premises is likely to be so considerable that the most stringent measures have to be taken to avoid loss by reason of the gold dust falling to the floor, getting caught in the workers' clothes, getting washed off his hands, and so passed to the drains, and in many other ways. An American jewellery trade paper says that some time ago a gold and silver manufacturing firm had occasion to put in a new floor in its work room, and the man who made the change simply took the old floor in payment of his work, and was well paid. In the process of manufacture it is impossible to avoid small particles of the precious metal flying upon the floor, where they are trodden into the crevices until the floor is saturated with them. The floor in a manufacturing jeweller's workshop, which has become so worn that it must be replaced, contains fully sufficient gold to pay for a new one. The shop sweepings are sent to the refiners' for the gold to be extracted. The process of extracting the gold from these sweepings is very simple. They are burnt, and the ashes are carefully collected; the buyer selects samples here and there, taking a portion from every part of the heap. These he weighs, puts through a grinder and sieve, then thoroughly mixes the product, takes a sample of it, weighs it, refines it and calculates how much gold there is in the whole quantity of ashes. From this he forms an estimate of the value and pays accordingly. Even the water in which the gold is washed when a ring or other article of jewelry is to be cleaned is preserved until there is sufficient quantity to make it worth while to separate the gold from it.

M. Positano, of Rome, has recently succeeded in making a modification of the well-known Daniell cell, increasing the electromotive force and intensity of the battery, without diminishing its constancy. M. Positano substitutes for the ordinary exciting element (water containing a certain percentage of sulphuric acid) a solution of chloride of ammonia of 25 per cent. strength; also, to increase the intensity, he replaces the hollow cylinder of copper by a spiral formed of several turns of strip copper. The pile, as modified, gives a current relatively intense, and the cell will find a new use in galvanic applications, and for electric clock service, as well as in telegraphic and other work where a constant current of small intensity is required.

"Pearl solder" is the misleading name applied to a very fusible solder employed for repairing articles containing pearls and other gems, when it is inconvenient to remove these. The color of pearls is easily destroyed by the heat essential to hard soldering, and so a special solder of low fusibility is necessary. Such a solder may be prepared as follows: Bismuth, 1 pwt. (.050 part); lead, 15 gr. (.031 part); tin, 9 gr. (019 part). This solder melts at about the boiling point of water, and is useful for many intricate little jobs. The flux used is venice turpentine, which does not leave a stain on the finished work if the heating is done with care.

Aluminum silver or silver metal is an alloy of copper, 57 parts; nickel, 20 parts; zinc, 20 parts, and aluminum, 3 parts; and it is coming into use for typewriter spacing levers. It is nickel-plated when the machine is new, but as the nickel wears off the metal still remains of a silver white color, which will not tarnish or rust. This metal is conceded to be better than brass, steel or iron for this special purpose; it is stiff and strong, does not cost more than brass, and is sufficiently hard to take a high polish.

It is said that radium has the property of completely neutralizing the poison of the viper, on fifty to sixty hours exposure.